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# Mammoth Cave Area, Kentucky

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Atlanta, GA

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Region 4
345 Courtland Street, NE
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APRIL 1981

EPA

# Environmental Impact Statement

Draft

# Mammoth Cave Area, Kentucky

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This Draft EIS addresses proposed wastewater facilities for the Mammoth Cave Area cities of Horse Cave, Cave City, Park City and Munfordville, Kentucky and the Mammoth Cave National Park. Eight wastewater management alternatives have been evaluated with particular attention to the sensitivity of the cave environment to wastewater discharges, the resource value and importance of the caves, the complexity of the area's subsurface hydrology and the financial impacts of the alternatives on the communities.

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APRIL 30, 1981

## NOTICE OF PUBLIC HEARING

TO ALL INTERESTED GOVERNMENT AGENCIES, PUBLIC GROUPS AND CONCERNED CITIZENS:

The United States Evironmental Protection Agency (EPA) will hold a public hearing on Monday, June 8, 1981, to receive public and agency comments on the Mammoth Cave Area Draft Environmental Impact Statement (EIS) and 201 Facilities Plan.

The public hearing will be held on June 8, 1981, at 7:30 P.M. (Central Time) in the Cave City Convention Center located on Kentucky Route 70, Cave City, Kentucky.

Both written and oral comments will be accepted and a transcript of the hearing will be made. Lengthy or technically complex statements should be summarized for the oral presentation. If possible, copies of the statements should be presented prior to the oral presentation. The Hearing Officer reserves the right to fix reasonable limits on the time allowed for oral statements.

A Final EIS will be published after the close of the Draft EIS public comment period. EPA does not intend to reprint the entire Draft EIS as part of the Final EIS. The Final EIS will consist of the Agency's decision, a summary of the Draft EIS, any pertinent additional information or evaluations developed since publication of the Draft, revisions to the Draft, comments received and EPA's responses, and the transcript of the public hearing. A copy of the Draft EIS should be retained if a complete evaluation of the project is desired.

The hearing record will remain open and additional written comments may be submitted until June 15, 1981. All additional comments that are received during the comment period will be considered as part of the hearing record.

1.a

Written comments should be forwarded to:

John E. Hagan III, P.E.
Chief, EIS Branch
EPA, Region IV
345 Courtland Street, N.E.
Atlanta, Georgia 30365
404/881-7458

Copies of the Mammoth Cave Area Draft EIS will be available for review at the following locations:

Horse Cave Free Public Library
Woodlawn Street
Horse Cave, Kentucky 42749

Hart County Public Library
3rd Street
Munfordville, Kentucky 42765

Mary Wood Weldon Memorial Library
107 West College
Glasgow, Kentucky 42141

Additional copies of the Draft EIS will be available from EPA's EIS Branch, at the address noted above.

Draft
Environmental Impact Statement

for
Mammoth Cave Area, Kentucky

Prepared by
U.S. Environmental Protection Agency
Region IV, Atlanta, Georgia 30365

This Draft EIS addresses proposed wastewater facilities for the Mammoth Cave Area cities of Horse Cave, Cave City, Park City and Munfordville, Kentucky and the Mammoth Cave National Park. Eight wastewater management alternatives have been evaluated with particular attention to the sensitivity of the cave environment to wastewater discharges, the resource value and importance of the caves, the complexity of the area's subsurface hydrology and the financial impacts of the alternatives on the communities.

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Rebecca W. Hanmer

Rebecca W. Hanmer
Regional Administrator

April 7, 1981
Date

i.c

# EXECUTIVE SUMMARY FOR ENVIRONMENTAL IMPACT STATEMENT

## MAMMOTH CAVE AREA WASTEWATER FACILITIES

### Mammoth Cave Area, Kentucky

Draft ( X )

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Environmental Protection Agency
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## EXECUTIVE SUMMARY

### PART A. EXISTING PROBLEM

The Mammoth Cave Area in Central Kentucky contains one of the nation's leading natural resources, the Flint-Mammoth Cave System. This is the largest cave system in the world and serves as both a major tourist attraction and a living laboratory of cave flora and fauna. In addition to the Flint-Mammoth Cave System there are many other caves in the area which also serve as part of this natural resource and bear the same attention.

The cave biological systems are extremely sensitive to outside influences. Unlike surface systems, cave systems renew themselves very slowly or not at all, if they are degraded by outside sources.

Much of the Central Kentucky Karst lacks surface streams. Therefore, the subsurface streams of the area have been used for wastewater disposal. Before there were any central wastewater collection and treatment systems in the area, the popular means of wastewater disposal was directly into the ground. This was achieved by discharging untreated wastewater directly to openings in the rock. Generally, this practice has been replaced by the use of septic tanks. However, because of soils, geologic formations and improper septic tank installation, much of the septic tank effluent drains directly into the sub-surface streams without proper treatment.

Eventually, centralized collection and treatment systems were constructed to serve both Cave City and Horse Cave. However, these systems were designed to discharge into sinkholes and eventually the subsurface stream system. This "solution" in many ways compounded the problem by discharging large quantities of wastewater directly into the subsurface streams without any awareness of the eventual impacts. Once again it was an expedient solution to a difficult problem, which resulted in more far ranging problems. To compound this problem, plant performance at both Cave City and Horse Cave has been unsatisfactory. This has resulted in discharges of wastewater with poor treatment and is the reason for many of the problems which presently occur in the subsurface receiving stream, Hidden River.

Much of the problem at the Horse Cave treatment plant has been caused by industrial flows, which have seriously inhibited treatment capability at that facility. The treatment plant was designed as a biological treatment plant to provide secondary levels of treatment. However, heavy inflows of industrial wastes from a metal plating facility and a cheese plant have hindered the biological treatment process. This has resulted in substantial amounts of poorly treated wastewater being discharged into the subsurface streams. These events have had significant impacts upon Hidden River.

Hidden River, which flows through Horse Cave has for many years caused significant odor problems in downtown Horse Cave. This is in contrast to the period from 1916-1944 when Hidden River Cave was a source of both recreation and water supply. Now, Hidden River is severely degraded, and the source of serious odor problems.

Problems in the area are further compounded by the proliferation of tourist related facilities, especially those along Kentucky, Route 70, which is a major entrance to the Park. Many of these facilities rely upon on-lot disposal systems. Additionally, Park City is served primarily by on-lot systems with approximately 80% of the residences and businesses discharging untreated wastewater directly to the subsurface. The remaining 20% have septic tanks which result in a direct discharge to the subsurface streams.

The major concern with the tourist facilities along Kentucky Route 70 and Park City is that they are in sub-surface drainage basins which flow into Mammoth Cave National Park and wastewater from improperly installed, operated, and maintained on-lot systems may affect subsurface water quality in and around the Park. Furthermore, the boundaries of the sub-basins are not fixed. They move in unknown ways depending on groundwater levels in the aquifer and on the flood stage of the surface rivers. This is caused by the filling of normally dry cave passages which may spill over into adjacent basins. This effect is particularly important with respect to Echo River Springs which is located in Mammoth Cave National Park. Under low flow conditions Echo River Spring derives its water almost entirely from the region of Mammoth Cave Ridge and much of its catchment is within the National Park. Under high flow conditions, a spillover occurs at an unknown point and water from the Park City-Cave City area of the Sinkhole Plain flows under the ridges to greatly augment the flow of Echo River spring. This implies that pollutants introduced in the more highly populated part of the Central Kentucky Karst could be carried into the National

Park, affecting aquatic life in the low level passages and even reaching portions of the cave close to those used by visitors.

Efforts to develop wastewater management systems that are compatible with the area's sensitive natural resources must also consider the local economic climate and the ability of the community to successfully support a wastewater management system. In this regard the financial impact of the wastewater management alternative on the communities in the study area is an additional concern that is critical to this EIS.

## PART B. DESCRIPTION OF ALTERNATIVES

The EIS was initiated in October, 1977. The focus of the EIS was to develop and evaluate wastewater management systems in the study area which would ensure the integration of environmental and economic considerations. During the development of the EIS certain issues were identified as the most significant in developing and selecting a wastewater management alternative. These included:

1. The sensitivity of the cave environment to wastewater discharges.
2. Resource value/importance of the caves.
3. Complexity of the area's subsurface hydrology.
4. Financial impacts of wastewater management systems and funding options.

To address these issues eight wastewater management alternatives were generated in the EIS. These eight alternatives range from a regional management concept involving local treatment and joint disposal by all population centers (except for Munfordville) to local treatment and local disposal of wastewater at each population center.

Each alternative was evaluated with respect to cost, impacts on the natural environment, and man-made environment and operability. From this evaluation three alternatives exhibited the greatest promise. A cost comparison of these three alternatives is presented below:

| Alternative # | Project Cost | Annual O & M | Net Present Worth |
|---|---|---|---|
| 2 | $10,574,000 | $261,000 | $11,620,000 |
| 5 | 6,546,000 | 230,000 | 7,975,000 |
| 8 | 5,876,000 | 249,000 | 7,630,000 |

Of additional concern in the evaluation of alternatives is the estimated user costs of the alternatives, and the local implications of these costs. These costs for alternatives 2, 5, and 8 for three of the communities are presented below:

| Alternative # | Horse Cave | Cave City | Park City |
|---|---|---|---|
| 2 | $39/yr/EDU* | $68 | $425-495 |
| 5 | $40 | 79 | 145-165 |
| 8 | $44 | 71 | 145-157 |

*Equivalent Dwelling Unit

NOTE: Horse Cave and Cave City existing user costs are not included.

The following paragraphs offer a description of Alternatives 2, 5 and 8 and the "pros" and "cons" of each.

### Alternative 2

1. Description of Alternative 2:

   This alternative involves the following components of a regional system:

   a. Local treatment facilities at each population center.

   b. Joint disposal of all effluent (except Munfordville) via surface water discharge (secondary treatment) to the Green River.

   c. Existing facilities at Cave City and Horse Cave would require upgrading.

   d. New facilities would be required at Park City and the Staging Area.

   e. Additional on-lot systems would be required at Munfordville.

   f. An inter-city conveyance and disposal line would be required.

2. Pros of Alternative 2:

   a. Provides greatest amount of protection for free flowing groundwater, groundwater supplies, sensitive cave systems and rare and endangered species by removing all wastewater discharges from the subsurface water network.

   b. Corrects existing water quality problems in the Hidden River groundwater sub-basin.

   c. Corrects existing odor problems in Horse Cave.

   d. Exhibits greatest overall system operability (reliability, flexibility and maintainability).

e. Has received the support of the communities, environmental/conservation groups and the National Park Service.

f. Provides service to existing development along Route 70 (between Cave City and the National Park) and affords protection of sensitive areas from wastewater discharges.

g. Received a high rating with regard to natural and man-made environmental impact.

3. Cons of Alternative 2:

a. Has the highest net present worth cost.

b. The cost to Park City would be prohibitive unless other funding sources could be tapped.

c. The potential exists for development to be encouraged along Route 70. In this instance, non-point source problems could adversely impact area cave systems.

d. There is currently no multi-city or county sewer authority to implement this option. Local communities are, however, in the process of developing one.

e. Considerable construction activity is associated with the inter-city conveyance and disposal line (114,000 feet of gravity lines and force mains).

Alternative 5

1. Description of Alternative 5:

This alternative involves the following components:

a. Local treatment facilities at each population center.

b. Joint disposal of Horse Cave's and Cave City's effluent via surface water discharge (secondary treatment) to the Green River.

c. Existing facilities at Horse Cave and Cave City would require upgrading.

d. Additional conventional and alternative on-lot systems would be required at Park City.

e. Additional on-lot systems would be required at Munfordville.

f. The Park's proposed Staging Area would employ on-lot systems.

2. Pros of Alternative 5:

a. Has the next to lowest net present worth cost.

b. Corrects the obvious water quality and odor problems in the Hidden River groundwater sub-basin by removing Horse Cave's and Cave City's sub-surface discharges.

c. As with #2 provides the greatest degree of protection of the groundwater system and cave environment for the Hidden River sub-basin.

d. Involves less than half of alternative 2's construction activity for the inter-city conveyance system (approximately 51,000 feet of gravity lines and force mains).

e. When compared to #2, the local cost is significantly less for Park City, slightly more for Cave City and the same for Horse Cave.

f. If the force mains from Cave City to Horse Cave to the Green River were designed to include flows from the Staging Area and Park City, this alternative could be the initial phase of what could eventually be a regional system to include Park City and the Park Service.

3. Cons of Alternative 5:

a. Existing residential and commercial developments now using on-lot systems in Park City and along Kentucky Route 70 would not be served. According to the Park Service's dye tracing studies these areas are drained by groundwater basins that flow through the Park. Although no problems have yet been detected, the potential does exist for the continued use of these on-lot systems to adversely impact these sensitive areas and the proposed critical habitat of the Kentucky Cave Shrimp within the boundaries of the Park.

b. The local cost to Cave City is slightly higher than #2.

c. System operability (reliability, flexibility and maintainability) is less than #2.

d. Although this alternative does address the water quality problems in Horse Cave and Cave City, it does not receive the support of the Park Service and other interests as does #2 because all sub-surface wastewater discharges are not removed.

## Alternative 8

## 1. Description of Alternative 8:

This alternative involves the following components:

a. Local treatment facilities at each population center.

b. Additional conventional and alternative on-lot systems at Park City.

c. On-lot systems at the Park's proposed Staging Area.

d. Cave City's existing facility would require upgrading for sub-surface discharge (advanced secondary treatment).

e. Horse Cave's existing facility would require upgrading for surface water discharge (secondary treatment) to the Green River.

f. Additional on-lot systems would be required at Munfordville.

## 2. Pros of Alternative 8:

a. Has the lowest net present worth cost.

b. Lowest local costs for Cave City and same local cost for Park City as in Alternative 5.

c. Removes Horse Cave's discharge from the Hidden River Sub-basin.

d. Least amount of construction activity for inter-city conveyance and disposal system (approximately 36,000 feet of gravity lines and force mains).

## 3. Cons of Alternative 8:

a. Existing residential and commercial developments now using on-lot systems in Park City and along Route 70 would not be served. According to the Park Service's dye tracing studies, these areas are drained by groundwater basins that flow through the Park. Although no problems have yet been detected, the potential does exist for the continued use of these on-lot systems to adversely impact these sensitive areas and the proposed critical habitat of the Kentucky Cave Shrimp within the boundaries of the Park.

b. Cave City's sub-surface discharge would not be removed. The potential for the Hidden River sub-basin to be adversely impacted by wastewater discharges does exist.

c. This option is rated lowest concerning impacts to the natural and man-made environment.

d. This option is rated lowest concerning systems operability (flexibility, reliability, and maintainability).

e. This option has received the least amount of support from the Park Service, study area communities and interested groups and individuals.

f. Although wasteload allocations for sub-surface discharges have been developed, a lesser degree of confidence is attached to these allocations than to surface water discharges.

g. This option would preclude the possibility of Park City or the Park Service being served by a regional system.

## PART C. PREFERRED ALTERNATIVE

The underlying theme of the EIS is that the provision of wastewater services should be compatible with efforts to preserve and protect this area's nationally significant cave systems and their unique physical, biological and historical resources. The National Park Service and the local EIS Citizen Review Committee have expressed their support for a regional wastewater management system that would afford the greatest protection of the area's cave and sub-surface water resources. Although a regional system is viewed as the environmentally preferred option, local economic constraints may dictate that another environmentally acceptable option be pursued. In light of the concerns regarding cost and the protection of the cave resources, a phased approach is recommended which will ultimately result in a regional (Alternative No. 2) or semi-regional (Alternative No. 5) wastewater management system.

This approach would involve the following components:

1. Initiate Phase I of the project which would provide for design for upgrading the treatment facilities at Cave City (0.37 MGD) and Horse Cave (0.53 MGD) and for conveyance facilities to the Green River. The conveyance facilities would be evaluated with and without future flows from Park City (0.08 MGD), the proposed Mammoth Cave National Park Staging Area (0.105 MGD), and the Route 70 area.

2. The establishment of a critical decision date to coincide with completion of the preliminary design for Horse Cave and Cave City for the NPS's decision regarding the development of the proposed Staging Area or the local

communities' commitment to obtain additional non-EPA funding sources.

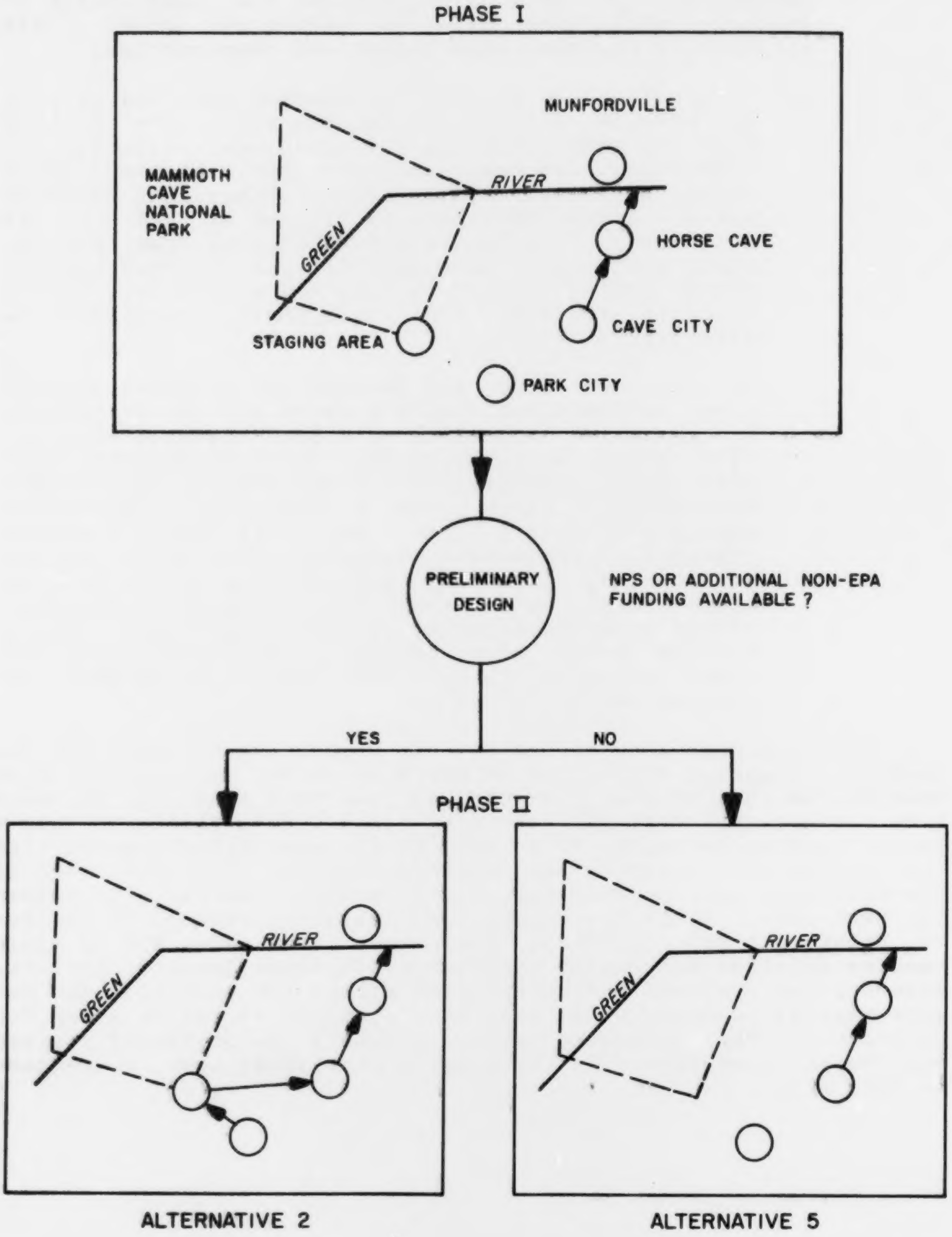
3. Provide final design for facilities based on the above decisions. At that point, EPA and the Commonwealth of Kentucky will also have to define the extent of EPA eligibility for remaining design and construction.

   a. If the NPS does develop the Staging Area and is able to provide significant funding assistance for Park City or additional non-EPA funds are available, the remaining components of the regional alternative could be constructed. These construction elements would involve treatment facilities at Park City and the Mammoth Cave National Park Staging Area, conveyance facilities from Park City to the Staging Area along Route 70 to Cave City and expand Cave City's facility to 0.58 MGD. This would, in essence, be Alternative 2.

   b. If the NPS does not develop the proposed Staging Area or additional non-EPA funds are not available, the remaining components of a semi-regional alternative would be constructed. This construction element would involve on-lot systems for Park City's residential areas and a community sub-surface absorption field for the Park City business district. Presently available funding mechanisms would allow for EPA participation in the cost of these activities but would be contingent on Congressional continuation of these mechanisms. Also, funding would have to be in accordance with the State priority list. This would, in essence, be Alternative 5.

The regional alternative is most responsive to local and the NPS desires regarding protection of the groundwater and the cave systems. However, because of high cost and the resultant financial burden to be seen locally, the regional alternative may not be viable at this time. Local funding decisions to be made in the near future are critical to the ultimate wastewater management system for this area. Additional non-EPA funds must be available for a regional system to be affordable to Park City. Until the appropriate decisions related to NPS funding or other non-EPA financial assistance are made, EPA is moving to resolve existing wastewater management and water quality problems. In essence, the proposed phased approach allows for resolving the current more serious problems while remaining flexible to future local funding decisions. The following figure presents the preferred approach to wastewater management in the Mammoth Cave study area, as recommended in this EIS.

# MAMMOTH CAVE AREA
# PREFERRED STRATEGY FOR WASTEWATER MANAGEMENT


PHASE I
MUNFORDVILLE
MAMMOTH CAVE NATIONAL PARK
RIVER
GREEN
HORSE CAVE
STAGING AREA
CAVE CITY
PARK CITY
PRELIMINARY DESIGN
NPS OR ADDITIONAL NON-EPA FUNDING AVAILABLE ?
YES
NO
PHASE II
RIVER
GREEN
RIVER
GREEN
ALTERNATIVE 2
ALTERNATIVE 5

DRAFT ENVIRONMENTAL IMPACT STATEMENT
MAMMOTH CAVE AREA KENTUCKY

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# CHAPTER I - PURPOSE OF AND NEED FOR ACTION

## PART A. PURPOSE OF THE EIS

Concerns within the past decade for preservation of the integrity of the environment led to the adoption of Public Law 91-190, the National Environmental Policy Act (NEPA) of 1969. Within this Act are the national environmental policies and goals intended to mitigate mistakes of the past through careful and coordinated planning efforts. As stated in the law the following declaration was issued: "a national policy shall be established which will encourage productive and enjoyable harmony between man and his environment; to promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man; to enrich the understanding of the ecological system and natural resources important to the Nation...."

In striving to meet these above stated goals P.L. 91-190 stipulates: "...include in every recommendation a report on proposals for legislation and other major Federal actions significantly affecting the quality of the human environment, a detailed statement by the responsible official on the environmental impact of the proposed action; and adverse environmental effects which cannot be avoided should the proposal be implemented; and alternatives to the proposed actions...." From this legislation arises the basic framework for the use of the Environmental Impact Statement (EIS).

The purpose of this particular EIS is to inform the public of potential impacts which may result from the proposed Federal action, i.e. the construction of wastewater facilities, and to enable public participation in the decision making process. The EIS is intended to resolve conflicts in the study area between wastewater disposal and the unique natural resources which exist in this area.

The EIS proposes to develop a preferred alternative for wastewater facilities in the study area. This alternative resolves many of those conflicts and will minimize environmental impacts throughout the study area.

## PART B. BACKGROUND AND ISSUES

The Mammoth Cave Area Environmental Impact Statement is being prepared to address the provision of wastewater management facilities for a portion of the Mammoth Cave National Park and four adjacent communities to the Park. The EIS study area is situated in the Central Kentucky Karst which is characterized by a gently rolling terrain pitted with sinkholes. The subsurface contains a complex structure of limestone caves and free-flowing groundwaters. The area's geological features are recognized unique national resources and provide the area with a strong tourist attraction at the National Park and other local commercial caves.

There are 5 major population centers in the study area. These include the municipalities of Munfordville (1975 population of 1,233), Horse Cave (1975 population of 2,068),Cave City (1975 population of 1,818), and Park City (1975 population of 576) and the proposed Staging Area at Mammoth Cave National Park. With the exception of Park City, these population centers maintain and operate wastewater treatment facilities. The disposal technique practiced by Munfordville and Mammoth Cave National Park is surface water discharge to the Green River. Treated effluent is disposed of in Horse Cave and Cave City, however, by direct discharge to adjacent sinkholes.

The Clean Water Act of 1977, represents the major legislative action for water pollution abatement in the United States. Under this legislation the U.S. Environmental Protection Agency has been given responsibility for the administration of the law including the funding of wastewater facilities.

The principal mechanism in P.L. 95-217 which provides for the construction of municipal wastewater treatment plants is Section 201. This Section provides grant funds for the planning, design and construction of wastewater facilities. Under the provision of Section 201 any wastewater facility which is newly proposed or under consideration for upgrading and or expanding which will use federal funds for construction must first proceed with a 201 Facilities Planning Study.

In 1977, EPA granted Step I funding for preparation of the Mammoth Cave Area 201 Facilities Plan. The project area, developed by the Kentucky Division of Water Quality includes the cities of Munfordville and Horse Cave in Hart County and Cave City and Park City in Barren County. In addition, consideration was given to the Mammoth Cave National Park. These cities are represented by the Barren River Area Development District (BRADD) in Bowling Green, Kentucky. BRADD is a regional planning and development agency who has been coordinating the 201 Facilities Plan for the study area. In 1977, BRADD hired Campbell Wallace Consulting Engineers of Knoxville, Tennessee to prepare the 201 Facilities Plan.

Due to the environmental complexities in the cave area and the financial and management constraints of the applicant cities, EPA made the decision to prepare an EIS in conjunction with the 201 Facilities Plan.

The EIS was initiated in September, 1977. The focus of the study was on the development and evaluation of alternative wastewater management systems in the cave area and to ensure the integration of environmental and economic considerations at the earliest stage of facilities planning. The major issues that were identified included:

- the determination of subsurface water uses and water quality goals
- resolution of local groundwater pollution problems, and

- resolution of local funding responsibilities and capabilities.

Subsequently a Notice of Intent was issued by the EPA Regional Administrator on October 5,1977. Gannett Fleming Corddry and Carpenter, Inc. was selected by EPA to perform the EIS and work began in September, 1977. Figure I-1 provides a description of the EIS study area.

During the EIS process major issue areas were defined. The following issues were determined to be the most significant:

1. The sensitivity of the cave environment to wastewater discharges.

2. Resource value/importance of the caves.

3. The complexity of the area's subsurface hydrology.

4. Financial impacts of wastewater management systems and funding options.

These issues were further investigated by extensive field sampling to obtain biological and chemical data from surface and sub-surface environments. Sampling was conducted throughout the study area under varied climatic and hydrologic conditions.

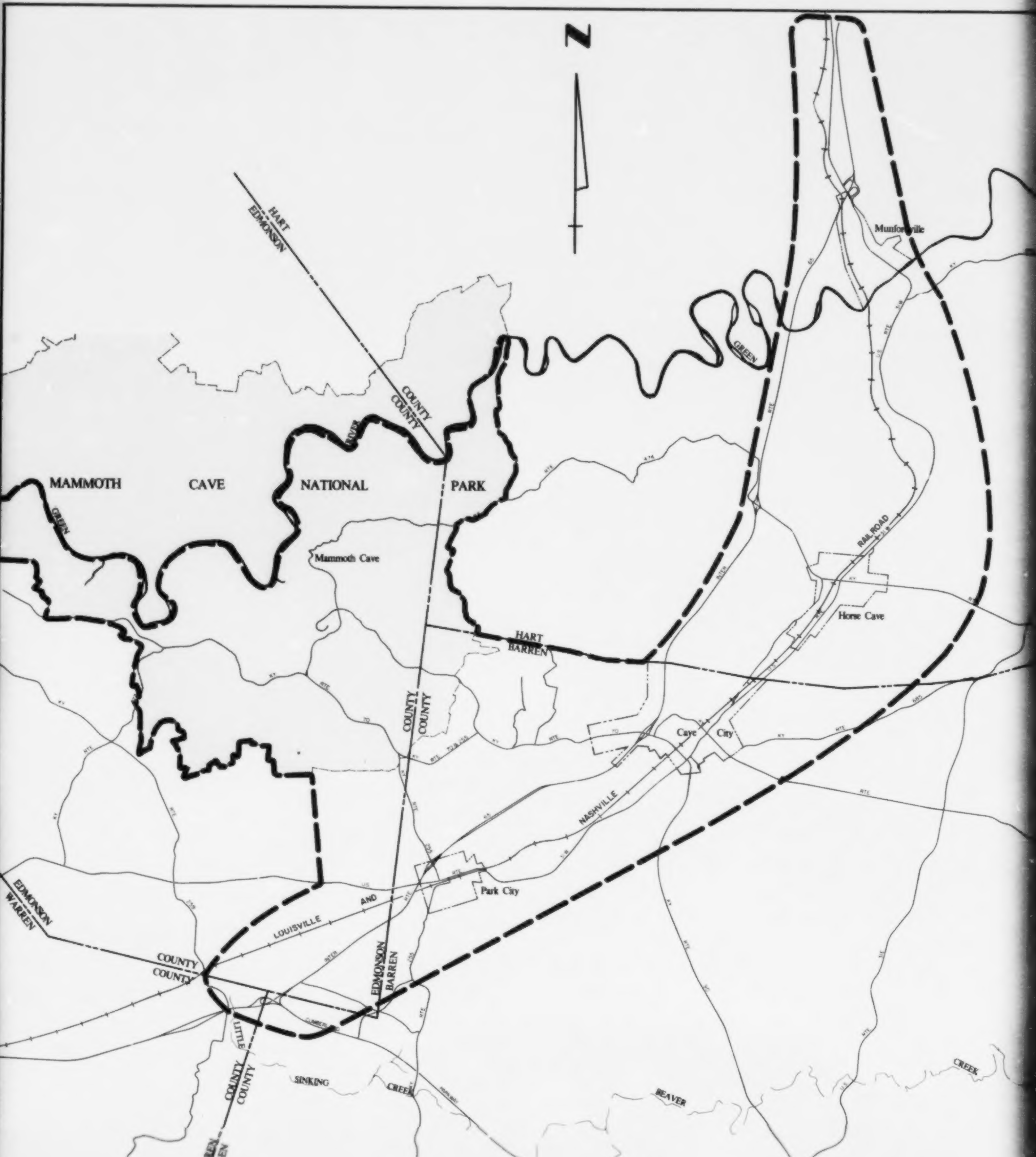
In conjunction with the development of the EIS, a Citizen Review Committee (CRC) was established to provide opportunities for interested groups, individuals, and governmental agencies to participate in the development of the EIS. In addition to the Citizen Review Committee a Groundwater Technical Advisory Committee (GTAC) was established to provide data review and input into the groundwater studies that were being conducted during the development of the EIS.

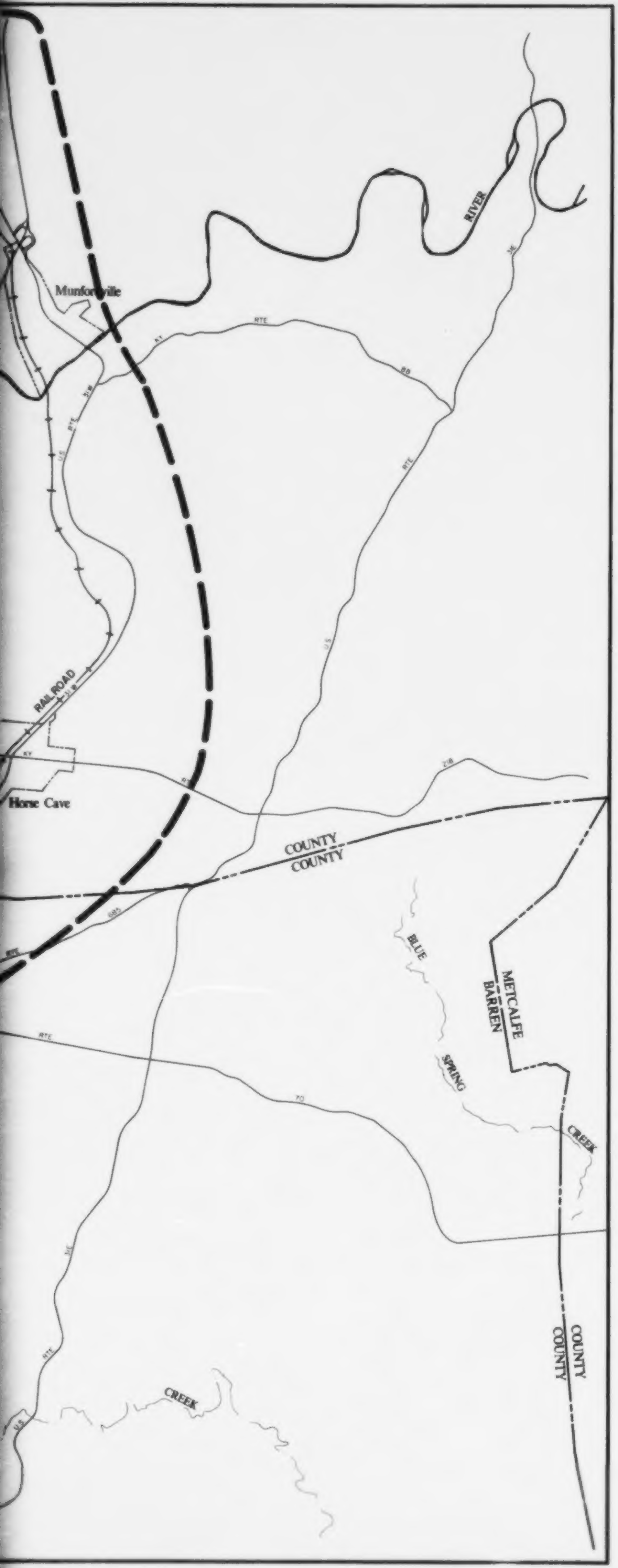
## PART C. 201 FACILITIES PLAN SUMMARY

### Introduction

The preliminary 201 Wastewater Facilities Plan for the Mammoth Cave Area was developed by Campbell Wallace Consulting Engineers of Knoxville, Tennessee. The Draft portions of the Plan were completed in December, 1978 and presented to the EIS Review Committee at its' meeting in February, 1979.

Chapter I of the study provides some background data, including the purpose for the study and a description of the area. In addition, the chapter presents a general description of geology, topography and economy, and a history of wastewater treatment in the area.


N
HART
EDMONSON
COUNTY
COUNTY
MAMMOTH
CAVE
NATIONAL
PARK
GREEN
RIVER
GREEN
Munfordville
Mammoth Cave
HART
BARREN
RAILROAD
Horse Cave
COUNTY
COUNTY
Cave City
NASHVILLE
Park City
LOUISVILLE
AND
EDMONSON
WARREN
COUNTY
COUNTY
EDMONSON
BARREN
LITTLE
SINKING
CREEK
BEAVER
CREEK
COUNTY
COUNTY
WARREN
BARREN


RIVER
Munfordville
KY
RTE
88
31E
RTE
U.S.
31W
RAILROAD
KY
218
RTE
Horse Cave
COUNTY
COUNTY
685
RTE
BLUE
SPRING
CREEK
METCALFE
BARREN
RTE
70
31E
RTE
U.S.
CREEK
COUNTY
COUNTY

## LEGEND

▨ MAMMOTH CAVE NATIONAL PARK

— — STUDY AREA LIMITS

FIGURE I - I

MAMMOTH CAVE AREA
201 FACILITIES PLAN

ENVIRONMENTAL IMPACT STATEMENT

STUDY AREA

12,000 6000 0 12,000 24,000
Scale In Feet

U.S. Environmental Protection Agency
Region IV Atlanta, Georgia

Chapter II of the Plan discusses land use planning in the study area, population and flow projections, surface and subsurface drainage basins, on-site and land disposal data, and estimated stream flows. Chapter III of the plan describes the existing wastewater systems and pollution sources.

These first three chapters develop background data for the preparation of Chapter IV. This chapter develops and presents wastewater treatment and disposal alternatives for the Mammoth Cave 201 Facilities Planning Area. The following section presents a summary of the alternatives developed by the 201 consultant.

## Summary of Preliminary 201 Facilities Plan Alternatives

In the 1978 draft portions of the 201 Plan, Campbell Wallace presented an analysis of alternative systems for each community or population center involved in the study. Alternative options are discussed with regard to each city acting independently.

Later, following a cost analysis, it is shown that viable interdependent alternatives exist for all wastewater collection agencies, but Munfordville. From this analysis, the consultant combines the various independent alternatives to come up with seven alternative combinations that include wastewater treatment and disposal options for Cave City, Horse Cave, Park City, and the National Park Staging Area. The following is a description of those seven preliminary alternatives.

Alternative #1. - Local disposal with Staging Area wastes going to the Mammoth Cave Green River Plant and Park City wastes going to Cave City.

Alternative #2. - Disposal at Horse Cave of Cave City, Horse Cave, and Park City wastes, and disposal of Staging Area wastes at the Mammoth Cave, Green River Plant.

Alternative #3. - Disposal at Cave City of Cave City, Park City, and Staging Area wastes, and local disposal at Horse Cave. This alternative calls for advanced secondary treatment at the Cave City and Horse Cave plants, secondary treatment at the Staging Area, and secondary treatment at Park City.

Alternative #4. - Tertiary treatment and disposal of wastes of Cave City, Horse Cave, Park City, and Mammoth Cave National Park Staging Area at Horse Cave.

Alternative #5. - Secondary treatment at Cave City, Horse Cave, and Park City with conveyance to the Green River Plant for advanced secondary treatment. In addition, the Staging Area wastes would be conveyed to the Mammoth Cave Green River Plant.

Alternative #6. Conveyance of wastewater from Cave City, Park City and the Staging Area to Cave City for advanced secondary treatment and local disposal. In addition, this alternative includes the pumping of secondary treated Horse Cave wastewater to the Green River for disposal.

Alternative #7. Disposal of Park City, Staging Area, and Cave City wastes at Cave City, and Horse Cave wastes at Horse Cave with construction of force main to Green River three years later.

Campbell Wallace then reviewed the major environmental considerations and the requirements of the National Park Service. As a result, it was determined that several features must be included if any alternative is to be considered viable. These features concerned, 1) the status of Park City wastes, whether the Staging Area is constructed or not; 2) the National Park does not want wastes pumped to the Green River Plant; and 3) since environmental considerations are related to the points of discharge and the treatment required for these discharges, they will limit the consideration of discharge points. Consequently, Alternatives 1, 2, and 5 were eliminated since the Mammoth Cave National Park did not want to treat its Staging Area wastes at its Green River Plant.

Furthermore, as a result of these environmental analyses and additional economic analyses, the number of viable alternatives was narrowed to two (2). They are:

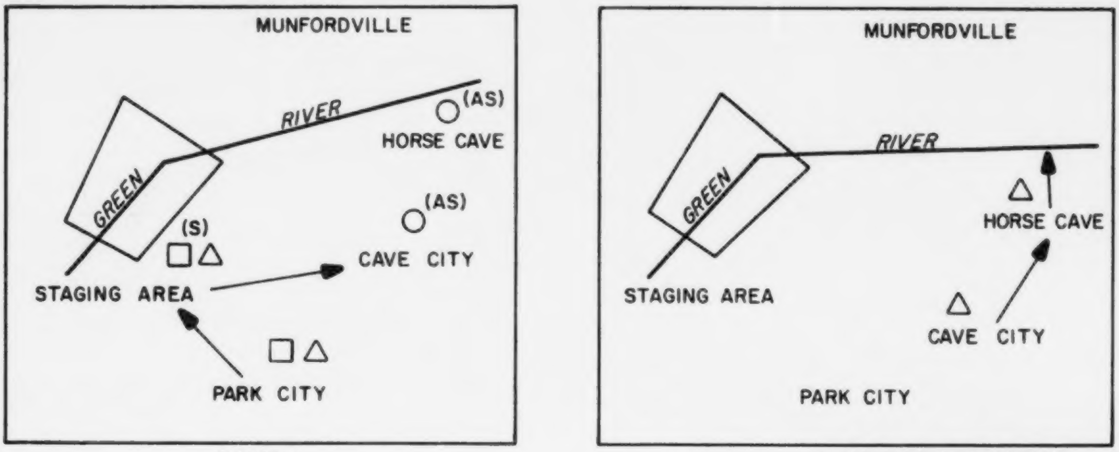
1. This alternative involves the pumping of secondary treated wastewater from Park City and the Staging Area to Cave City for local disposal. Also, this alternative calls for the upgrading of the Horse Cave plant to provide advanced secondary treatment, with local disposal. The later construction of a common discharge line from Cave City to Horse Cave to the Green River is planned, if required. This alternative corresponds to Alternative Number 3 as described above.

2. This alternative involves the pumping of secondary treated wastewater from Park City to the Mammoth Cave National Park Staging Area, and then to Cave City where the wastewater will be given advanced secondary treatment. This wastewater will then be pumped to Horse Cave. Wastewater initially collected at Horse Cave will be given less than secondary treatment. The advanced secondary treated wastewater from Cave City and the less than secondary treated wastewater from Horse Cave will then be conveyed to the Green River for disposal. This alternative corresponds to Alternative Number 6. See Figure I-2 for a description of the recommended 201 Facilities Plan Alternatives.

A revised draft plan that has evaluated the more feasible alternatives that were identified in the EIS has also been completed.

FIGURE I-2

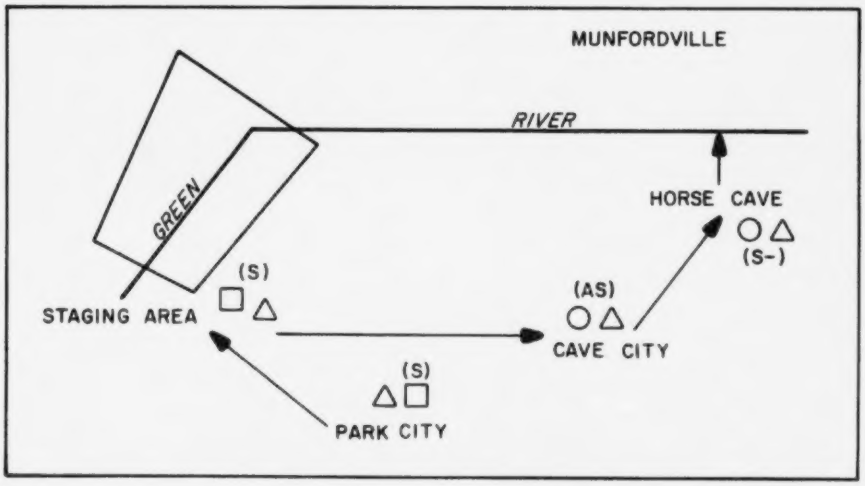
# 201 FACILITIES PLAN RECOMMENDED WASTEWATER MANAGEMENT ALTERNATIVES


MUNFORDVILLE
GREEN
RIVER
(AS)
HORSE CAVE
(AS)
CAVE CITY
(S)
STAGING AREA
PARK CITY
MUNFORDVILLE
GREEN
RIVER
HORSE CAVE
CAVE CITY
STAGING AREA
PARK CITY

PHASE 1

PHASE 2 (IF REQUIRED)

ALTERNATIVE 1


MUNFORDVILLE
GREEN
RIVER
HORSE CAVE
(S-)
(AS)
CAVE CITY
(S)
STAGING AREA
(S)
PARK CITY

ALTERNATIVE 2

**LEGEND**

| | |
|---|---|
| — | FORCE MAIN |
| ○ | UPGRADED EXISTING FACILITY |
| △ | PUMPING STATION |
| □ | NEW WASTEWATER TREATMENT FACILITY |

| | |
|---|---|
| (S) | SECONDARY |
| (AS) | ADVANCED SECONDARY |
| (S-) | LESS THAN SECONDARY |

# CHAPTER II-ALTERNATIVES DEVELOPMENT AND EVALUATION

## PART A. INTRODUCTION

The purpose of this chapter is to provide a systematic development of all reasonable alternatives for the attainment of the objectives of this project and to compare these alternatives with the aim of identifying critical differences and selecting an alternative.

This chapter presents a range of structural engineering alternatives and nonstructural considerations for the solution of wastewater management problems. In addition, alternatives are evaluated for their engineering and environmental feasibility. The structural alternatives identified include the construction of new wastewater treatment and conveyance facilities or the upgrading of existing facilities. Eight structural alternatives for wastewater management were developed for this study and they are described in this chapter. Applicable treatment and disposal methods, including various land application techniques, are also discussed and evaluated.

Non-structural wastewater considerations discussed include optimum use of existing facilities, flow and waste reduction measures, land and development controls, and management of industrial wastewater from Ken Dec, Inc. and Hart County Creameries, Inc.

Additional factors used in evaluating and comparing alternatives were cost-effectiveness, operability, and implementability.

Wastewater flow projections for the project have also been developed and finalized. EIS and 201 Facilities Plan draft wastewater flow projections for each major population center are compared (see Table II-1) and a final EIS projection is indicated for use in alternatives evaluation. Rationales for selecting the final EIS projections are as follows:

Cave City - There is really no significant difference between the two projections. The EIS projection is selected to keep the report as consistent as possible.

Horse Cave - The 201 Facilities Plan projection is significantly larger than the EIS projection. This is because the EIS projects Ken Dec water use reductions of 40%. This is not considered to be practical at the present since there is no commitment from Ken Dec. Therefore, the 201 projection is selected. However, letters of intent agreements must be obtained by Horse Cave, as part of the 201 process, to establish the capacity to which Ken Dec will be committed.

Park City - The EIS projection is about 33% larger than the 201 projection. It does not appear that the 201 projection accounts for the peak seasonal flows in Park City due to the expected tourist population increase associated with the construction of the proposed National Park staging area near Chaumont.

### TABLE II-1
### PROJECTED DESIGN WASTEWATER FLOWS FOR MAMMOTH CAVE STUDY AREA POPULATION CENTERS

| Municipality | Design Year | EIS Projection mgd($m^3$/day) | 201 Facilities Plan Projection mgd ($m^3$/day) | Final EIS Projection mgd ($m^3$/day) |
|---|---|---|---|---|
| Cave City | 2000 | 0.37 (1400.60) | 0.398 (1506.59) | 0.37 (Less than 10% difference)(1400.60) |
| Horse Cave | 2000 | 0.41 (1552.01) | 0.527 (1994.91) | 0.53 (2006.26) |
| Park City | 2000 | 0.08 (302.83) | 0.06 (227.12) | 0.08 (302.83) |
| Munfordville | 2000 | 0.15 (567.81) | 0.164 (620.81) | 0.15 (Less than 10% difference) (567.81) |
| National Park | | | | |
| Staging Area | 2000 | 0.08 (302.83) | 0.06 (227.12) | 0.08 (302.83) |
| Historic Entrance (Concessions, campground and residential area) | 2000 | 0.04 (151.42) | 0.08 (302.83) | 0.04 (151.42) |

NOTE: These flows are subject to revision following EPA's final evaluation.

SOURCES: Gannett Fleming Corddry and Carpenter, Inc. Campbell Wallace. Preliminary 201 Wastewater Facilities Plan.

Munfordville - The 201 projection is slightly higher apparently because more customers are anticipated than indicated by EIS estimates. However, the difference is considered to be insignificant (<10%). The EIS estimate is selected to maintain consistency. One adjustment made to the EIS estimate increased the flow by approximately 30,000 gpd to account for estimated infiltration. Combined infiltration/inflow (I/I), was considered a factor in Munfordville only since no seasonal variations in wastewater exist in the community, as they do in Cave City, Horse Cave, Mammoth Cave National Park, and to some extent, Park City.

National Park - The EIS distribution estimates are selected as the final EIS flow projections for the Staging Area and Historic Entrance. This wastewater flow projection is 0.04 mgd, only one-half of that projected by the 201 Plan.

## PART B. IDENTIFICATION AND DEVELOPMENT OF WASTEWATER SERVICE CONFIGURATIONS AND SYSTEMS

The development of alternatives for wastewater treatment in the Mammoth Cave area is accomplished in two phases. The first consists of developing alternative wastewater service configurations. A service configuration is a distinct plan for providing wastewater treatment and disposal services to each major population center in the study area, either by local treatment/disposal, or joint treatment/disposal by two or more population centers. It does not include options for the actual treatment and disposal methods but rather service conveyance configurations and disposal locations.

The development of these service configuration alternatives first involves determining the major population centers in the study area and then identifying various combinations of two or more population centers for which joint treatment/disposal appears to have economic and/or environmental advantages over local treatment/disposal and, therefore, requires further evaluation. Finally, the alternative service configurations for the area are established by the combination of local and joint wastewater treatment/disposal service schemes.

The second phase of alternatives development involves screening various wastewater treatment/disposal techniques for applicability in the Mammoth Cave study area and generating treatment/disposal options for local treatment/disposal at each population center as well as for each joint treatment combination (joint treatment/disposal) which appears in the service configuration alternatives. These treatment/disposal options provide only for the level of treatment (e.g. secondary or advanced secondary) and for the method of disposal (e.g. discharge to surface waters or spray irrigation).

This two phase approach is intended to provide increased understanding of the alternatives development method as well as ease of evaluation. The cost-effective evaluation of individual local and joint wastewater treatment/disposal options is completed as a first evaluation step. Recommended cost-effective options are incorporated into the service configurations to formulate a limit of number of wastewater management alternatives for final evaluation.

## 6. ALTERNATIVE WASTEWATER SERVICE CONFIGURATIONS

There are presently five major "population centers" (wastewater sources) in the Mammoth Cave, Kentucky 201 study area: Mammoth Cave National Park, Park City, Cave City, Horse Cave and Munfordville. The National Park "population" will be divided between the proposed Staging Area and the Historic Entrance area. However, only the Staging Area at the National Park will be considered as a major population center for alternatives development purposes. The Staging Area is proposed to be located at the Park boundary and is the site of a proposed new visitors center. The remainder of the Parks "population" is at the Historic Entrance, and includes campgrounds, park concessions, employee residences and park administration buildings. According to the management of Mammoth Cave National Park, any conveyance of wastewater through the National Park is unacceptable, thus, isolating the Historic Entrance area and eliminating the possibility of any joint treatment/disposal options involving the Historic Entrance area. Furthermore, all wastewater services for the Historic Entrance area are to be handled independently by the National Park Service.

There are many smaller wastewater sources in the study area, including some small unincorporated residential communities, motels and campgrounds outside the major municipalities, and schools or businesses located in existing or proposed municipal sewerage service areas that are sewered by small wastewater treatment facilities. None of these are considered to be major wastewater sources or to significantly impact alternatives development. In addition to the five major population centers, only one other area is to be considered in developing wastewater management alternatives. Tourist industry related development along Route 70 west of the I-65 Cave City interchange to the National Park entrance appears to represent a significant source of wastewater. This area is included in the development of wastewater alternatives primarily because of the potential adverse impacts to the Mammoth Cave System from the continued use of individual subsurface wastewater disposal systems.

Although wastewater treatment and disposal in the study area is presently handled locally, economic and/or environmental considerations may necessitate combining wastewaters from two or more population centers for joint treatment and disposal. There are several joint treatment/disposal configurations for study area population centers that, because of the potential economic or environmental advantages, require further evaluation. These are presented and described in Table II-2.

Given the joint treatment/disposal combinations to be considered, as well as local treatment/disposal, there are several possible alternative wastewater service configurations combining local and joint treatment/disposal approaches to wastewater management. Wastewater service configuration alternatives for the study area are presented in

# TABLE II-2 COMBINATIONS OF POPULATION CENTERS FOR JOINT TREATMENT/DISPOSAL TO BE CONSIDERED FOR FURTHER EVALUATION

| Population Centers Combinations for Joint Treatment/Disposal | Joint Treatment/Disposal Combination Identification | Conveyance Facilities and Discharge Location | Major Consideration(s) for Further Evaluation |
|---|---|---|---|
| **Staging Area**<br>**Park City**<br>**Cave City**<br>**Horse Cave** | SA-PC-CC-HC | Conveyance facilities: Staging area to Park City to Cave City to Horse Cave<br>Treatment and discharge to Green River | Environmental consideration of eliminating all subsurface discharge |
| **Park City**<br>**Staging Area**<br>**Cave City**<br>**Horse Cave** | PC-SA-CC-HC | Conveyance facilities: Park City to Staging Area to Cave City to Horse Cave<br>Treatment and discharge to the Green River | Environmental considerations of eliminating all subsurface discharges including those resulting from disposal systems serving the Rt. 70 development area where subsurface drainage enters Mammoth Cave National Park Cave systems |
| **Park City**<br>**Cave City**<br>**Horse Cave** | PC-CC-HC | Conveyance facilities: Park City to Cave City to Horse Cave<br>Treatment and discharge to Green River | Environmental consideration of eliminating subsurface discharge |
| **Staging Area**<br>**Cave City**<br>**Horse Cave** | SA-CC-HC | Conveyance facilities: Staging Area to Cave City to Horse Cave | Environmental considerations of eliminating subsurface discharges from Cave City and Horse Cave as well as those from disposal systems serving the Rt. 70 development where subsurface drainage enters Mammoth Cave National Park systems |
| **Cave City**<br>**Horse Cave** | CC-HC | Conveyance facilities: Cave City to Horse Cave<br>Treatment and discharge to subsurface, Green River or land application system | Possible economies of scale in treatment plant construction and operation; Environmental consideration of eliminating subsurface discharges (Green River disposal) |
| **Park City**<br>**Cave City** | PC-CC | Conveyance facilities: Park City to Cave City<br>Treatment and discharge to subsurface at existing Cave City site or treatment and land application | Environmental consideration of eliminating potential Park City discharges to Echo-Styx groundwater basin |
| **Staging Area**<br>**Cave City** | SA-CC | Conveyance facilities: Staging Area to Cave City (via Rt. 70)<br>Treatment and land application | Environmental consideration of providing wastewater services to the Rt. 70 development area eliminating drainage from subsurface disposal systems from the area entering the National Park cave systems |

Figures II-3 to II-10 in Chapter II, Part E, Wastewater Management Alternatives Evaluation.

Munfordville is the only population center not considered as a part of any joint treatment/disposal scheme, for three reasons: 1) the Munfordville wastewater treatment facility is considered adequate, with certain relatively limited improvements, to serve the needs of the Munfordville area, 2) conveyance of wastewaters to Munfordville for discharge to the Green River instead of to a point closer to Horse Cave would require several additional miles of force main, probably off-setting any economies of scale realized by including the Munfordville plant in a regional facility, and 3) the present Munfordville treatment plant site is unsuitable for a regional facility, thus requiring additional conveyance of Munfordville wastewaters to a new site.

## 2. IDENTIFICATION OF APPLICABLE TREATMENT AND DISPOSAL METHODS

For each of the local or joint treatment/disposal schemes identified, alternative treatment and disposal method's must be developed. This section identifies and evaluates various treatment and disposal methods for application in the study area.

### Treatment and Discharge to Surface Waters

Wastewater treatment and discharge to surface waters is the most commonly used wastewater management technique. It consists of treating wastewater by a combination of physical, chemical and/or biological processes and discharging the effluent to a receiving stream via an outfall.

In the Mammoth Cave Area, the Green River is the only surface stream large enough to assimilate wastewater. The segment of the Green River at Munfordville has an estimated 7-day, 10-year low flow of approximately 160 cfs (103 mgd) (U.S. Geological Survey, Water Resources Report) and is effluent limited. "Effluent limited" means that wastewater treatment plant effluents which are discharged to the Green River must meet secondary treatment levels as defined by EPA (30 mg/l BOD and 30 mg/l TSS). This level of treatment is considered adequate to protect water quality in the Green River.

The assimilative capacity of the Green River is large enough to accommodate a substantial volume of secondary effluent; therefore, there are several local and joint treatment/disposal alternatives which can be developed involving secondary treatment facilities and discharge to the Green River. Potential discharge points to be considered in developing wastewater treatment/disposal options are Munfordville and downstream from Munfordville near Lawler Bend.

## Treatment and Discharge to the Groundwater

There are many free flowing subsurface streams in the Mammoth Cave area which are tributary streams of surface waters. In this area there are two existing municipal groundwater discharges. The Horse Cave wastewater treatment plant discharges to the Hidden River Cave South Branch, the Cave City plant to a tributary of the Hidden River Cave East Branch.

Only two locations in the study area are considered for subsurface discharge: 1) the existing Cave City discharge point tributary to Hidden River Cave East Branch; and 2) Hidden River Cave downstream from the confluence of the East and South branches. Park City is not considered acceptable because the exact location of the stream(s) is unknown and because subsurface drainage from the area flows to Mammoth Cave National Park.

The existing Cave City discharge point is considered because results from limited base flow sampling do not indicate significant water quality degradation in the East Branch downstream from the Cave City discharge, even though secondary treatment was not being achieved during the sampling period. The conditions in groundwaters between the discharge and the East Branch sampling point in Hidden River Cave, however, are unknown. A discharge point at Horse Cave located downstream from the confluence of the East and South branches is considered because a dilution ratio of approximately 8:5 for the projected Horse Cave year 2000 design flow should provide some assimilative capacity for discharge of adequately treated wastewater.

Effluent limitations have been developed for Hidden River by the Water Quality Standards Section of EPA, Region IV. These limitations were based upon a modified Streater-Phelps model, developed for simulating water quality in free-flowing streams. Agreement has now been reached between EPA, Region IV and the Kentucky Department of Natural Resources and Environmental Protection on effluent limitations for Hidden River. Table II-3 presents a listing of effluent limitations established for Hidden River. Each alternative has a primary and alternative effluent limitation.

## Treatment and Land Application

Land application of treated wastewater provides for further removal or reduction of pollutants by physical and/or biological processes which occur in the soils. The successful operation of a land application system is dependent upon the characteristics such as soil structure and chemistry, topography, geology, hydrology, climate and vegetation. The land-treated wastewater is removed from the soil by evapo-transpiration and is returned to surface streams by runoff or percolates downward through the soil to the groundwater.

There is potential for using land application techniques for wastewater treatment and disposal in the Mammoth Cave study area. The

## TABLE II-3
## EFFLUENT LIMITATIONS

Proposed Discharge

(1) Cave City and Horse Cave discharges at present location

| | FLOW ($m^3$/day) | $BOD_5$ | $NH_3$ | DO |
|---|---|---|---|---|
| Cave City | .4 MGD<br>(1514) | 30 mg/l | 4 mg/l | 5 mg/l |
| Horse Cave | .53 MGD<br>(2006) | 10 mg/l | 3 mg/l | 5 mg/l |
| Alternative Limits | | | | |
| Cave City | .4 MGD<br>(1514) | 15 mg/l | 4 mg/l | 5 mg/l |
| Horse Cave | .53 MGD<br>(2006) | 15 mg/l | 4 mg/l | 5 mg/l |
| With Park City at Cave City | | | | |
| Cave City | .46 MGD<br>(1741) | 15 mg/l | 3 mg/l | 5 mg/l |
| Horse Cave | .53 MGD<br>(2006) | 15 mg/l | 4 mg/l | 5 mg/l |

(2) Combined discharge at the confluence of East and South Branch

| | FLOW | $BOD_5$ | $NH_3$ | DO |
|---|---|---|---|---|
| | .93 MGD<br>(3520) | 10 mg/l | 3 mg/l | 5 mg/l |
| With Park City waste | .99 MGD<br>(3748) | 8 mg/l | 3 mg/l | 5 mg/l |

(3) Cave City discharge only

| | FLOW | $BOD_5$ | $NH_3$ | DO |
|---|---|---|---|---|
| | .40 MGD<br>(1514) | 25 mg/l | 15 mg/l | 5 mg/l |
| With Park City waste | .46 MGD<br>(1741) | 20 mg/l | 15 mg/l | 5 mg/l |

(4) Horse Cave discharge only

| FLOW | $BOD_5$ | $NH_3$ | DO |
|---|---|---|---|
| .53 MGD<br>(2006) | 20 mg/l | 4 mg/l | 5 mg/l |

(5) Discharge to Green River

Because of the large , 7 day, 10 year low flow, approximately 160 CFS, (4.37 $m^3$/s) effluent limits for any of the above discharges would be secondary treatment.

most widely considered land application techniques - septic tank/soil absorption for individual homes or small communities; and spray irrigation, rapid infiltration and overland flow for centralized severage systems serving larger populations are described briefly below. In addition, the applicability of each technique to meet wastewater treatment needs at the population centers in the study area is assessed.

Septic Tank/Soil Absorption System - Use of conventional individual on-lot septic tank/soil absorption systems is acceptable in areas with relatively low population densities and favorable soil, geologic, climatic and hydrologic conditions. Use of these systems is most often limited by one or a combination of the following conditions: 1) Unsuitable soil permeability; 2) Shallow depth to bedrock or fragipan; 3) Shallow depth to seasonal high water table; or 4) Excessive slopes. If the limitations are not severe, use of modified septic tank/soil absorption systems may be acceptable. Site modifications may include grading and/or filling, while absorption system modifications may include constructing subsurface sand filters or elevated sand mounds. Septic tank/soil absorption systems may be used either with individual on-lot systems or a community-sized system may be implemented in small communities where population densities are too high for individual on-lot systems but other conditions are favorable.

Soil associations in the proposed Staging Center area are moderately to severely limited for septic tank/soil absorption systems, primarily due to the shallow depth to bedrock. Some modifications may be possible to develop an adequate absorption system; however, the estimated volume of wastewater to be treated during peak tourist season (average 80,000 gpd year 2000) is considered too great. However, conditions appear to be suitable for accommodating a smaller volume of treated greywater from hand washing, drinking fountains and clean-up.

The potential for using septic tank/soil absorption systems is probably greatest in Park City. Soil associations in the area are generally adequate and community systems may be appropriate for the populated areas in the center of town.

In Munfordville, approximately half of the population uses individual on-lot septic tank/soil absorption systems (with no reports of serious malfunctions) while the remainder of the population is served by the Munfordville severage system. Continued use of these on-lot systems may be a viable alternative for providing wastewater treatment and disposal in unsewered areas of Munfordville.

Although soil associations in the Horse Cave and Cave City areas are generally adequate, the use of on-lot systems is not considered to be a practical alternative since population densities are too high. However, future development on the outskirts of these communities could include use of septic tank/soil absorption systems for wastewater treatment and disposal.

Rapid Infiltration - The rapid infiltration technique involves land application of treated wastewater to a relatively high-permeability soil. Most of the applied wastewater percolates rapidly downward, eventually reaching groundwater. Filtration and adsorption in the soils accounts for nearly complete removals of suspended solids, BOD and fecal coliform. This type of land application technique is not well-suited for conditions in the Mammoth Cave area. Generally, the permeability of soils in the Mammoth Cave area is too low. In addition, depths to groundwater or bedrock are too shallow.

Overland Flow - In the overland flow technique, treated wastewater is applied over the upper reaches of sloped terraces and allowed to flow across vegetated surfaces (2-8% slopes) to runoff collection ditches and is discharged to a receiving stream. Waste constituents are removed by physical, chemical and biological means as the wastewater flows in a thin film over soils which are usually relatively impermeable. Overland flow appears to produce a high quality effluent, with BOD and suspended solids averaging approximately 10 mg/l and ammonia nitrogen less than 1 mg/l (EPA Land Application Manual).

The overland flow land application technique is not considered particularly well-suited for use in the Mammoth Cave area because soils are generally not impermeable and because there are no receiving streams for overland flow discharge. Drainage from an overland flow system located in the vicinity of Park City, Cave City or Horse Cave (sinkhole plain area) would enter the subsurface, generally at the base of a sinkhole. Because of the instability of sinkhole soils-rock structure, this method does not appear to be satisfactory. Erosion caused by the drainage system could cause collapse of the sink or sink drainage could clog, producing ponding of treated wastewater.

The vicinity of the proposed Staging Area is not considered well-suited for an overland flow system, primarily because of the steep slopes in the area. In addition, discharge to the subsurface waters of the National Park is not considered an acceptable alternative.

Slow Rate (spray irrigation) - Of the three techniques described here, slow rate (spray irrigation), rapid infiltration, and overland flow, only spray irrigation is considered in the development of wastewater treatment disposal options. This technique applies treated* wastewater to a vegetated area where a portion of the water is treated as it percolates slowly through the soil to groundwater and the remainder of the water is removed by evapo-transpiration. This technique not only provides a high degree of treatment, but also provides for some economic return from crops which take up nutrients in the wastewater.

Soil conditions in the Horse Cave and Cave City areas generally appear to be adequate to warrant investigating the possibility of using a slow rate land application system to meet wastewater treatment needs at these population centers. There are two disadvantages to application of this system in these areas: 1) Land requirements would be substantial due to the large volume of wastewaters generated in these areas; 2) Unless treated wastewaters could be discharged to the subsurface during winter months, the wet weather storage requirements would be a significant cost factor. Year-round slow rate land application is considered to be a possible alternative for Park City since soils are generally suitable and flows much smaller.

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* The assumed pre-application treatment of spray irrigation systems included in treatment/disposal options developed for the Mammoth Cave area is secondary treatment. Although EPA Program Requirements Memorandum (PRM) 79-3 states that a universal requirement of secondary treatment is excessively stringent, secondary treatment is considered necessary in this area to protect subsurface waters from drainage from spray irrigation systems.

Spray irrigation is not considered a viable alternative at the Staging Area primarily due to shallow depths to bedrock. Because the wastewater cannot percolate downward, the soils at the irrigation site would become saturated and destroy the vegetative cover. In turn, the applied wastewater would then appear as surface runoff.

### Waterless Composting Toilets

A composting toilet consists of an impervious container with a sloping bottom and some type of mechanism for allowing the organic wastes to move slowly down the sloping bottom as they are aerobically decomposed. Since the process is well vented and because it is aerobic, it is generally free of offensive odors. The end products are carbon dioxide, and water vapor (both vented) and humus, however the volume of humus represents only about 5 to 10 percent of the original waste volume. This humus is generally safe for land spreading, even in vegetable gardens.

This approach is not a practical alternative on a large scale, however, composting toilets may prove useful at the Staging Area. Potential advantages of using this type of system include cost savings (especially in the case of the Staging Area, where facilities could be provided at construction, avoiding expensive building alterations), wastewater reductions, and water and energy conservation.

### Specific Wastewater Treatment/Disposal Options

Tables II-4 and II-5 present the various treatment-disposal options developed for the major population centers of the study area. Table II-4 contains local treatment-disposal options for each major population center combination indicated in the alternative wastewater service configurations.

## 3. IDENTIFICATION OF WASTEWATER COLLECTION SYSTEM ALTERNATIVES

Typical wastewater collection systems are composed of conventional gravity sewers and force mains. Gravity sewers convey waste-

# TABLE II-4 LOCAL WASTEWATER TREATMENT AND DISPOSAL OPTIONS

| Population Center | Option Identification | Description of Treatment | Disposal Method and Location | Reason for Further Evaluation |
|---|---|---|---|---|
| **Park City** | PC-1 | Secondary treatment | Spray irrigation land application system; south of business district of Park City | Provides for centralized treatment/disposal facilities to serve Park City. Local disposal eliminates conveyance costs |
| **Park City** | PC-2 | Septic tank/soil absorption systems. Individual systems to serve homes and business establishments which presently discharge directly to the ground water; community soil absorption systems where individual systems are not practical | Land application by soil absorption systems in and around Park City | Properly operated septic tanks and soil absorption systems provide a low cost, low energy use solution to wastewater treatment. There are no conveyance costs and minimal collection costs. No large, single volume of wastewater is discharged directly to the groundwater |
| **Staging Area** | SA-1 | Composting, waterless toilets. Septic tank/soil absorption field for greywater from handwashing | Land spreading of composted wastes. Soil absorption field for greywater | Relative to other systems, costs for construction and operation are low. This system provides for water and energy conservation and eliminates any need for conveyance facilities through the National Park |
| **Cave City** | CC-1 | Advanced secondary treatment; Class I reliability; new facility | Discharge to subsurface waters at existing site in the Hidden River Cave system | Advanced secondary treatment appears to be adequate to protect water quality in the Hidden River Cave system. The system provides for use of existing facilities |
| **Cave City** | CC-2 | Secondary treatment; Class III reliability (adequate dilution during wet season) | Land application during dry months and subsurface discharge at existing site during wet months | This plan eliminates discharge of wastewater to subsurface under base flow conditions and reduces the costs of Class I reliability secondary advanced wastewater treatment |
| **Cave City** | CC-3 | Advanced secondary treatment (Class I reliability); upgraded existing facilities | Discharge to subsurface waters at existing site in Hidden River Cave system | This provides a potential least cost solution for Cave City and provides for improved treatment using existing facilities |
| **Horse Cave** | HC-1 | Advanced secondary treatment (Class I reliability); updated existing facilities; equalization of industrial wastewaters | Discharge to subsurface in Hidden River Cave system downstream from the confluence of the East and South branches | This appears to provide a potential least cost local alternative |
| **Horse Cave** | HC-2 | Secondary treatment (Class III reliability); updated existing facilities; equalization of industrial wastewaters | Land application at Horse Cave during dry months and subsurface discharge to Hidden River Cave system downstream from East and South Branch confluence during the wet months | This eliminates discharge to subsurface during critical base flow periods |
| **Horse Cave** | HC-3 | Advanced secondary treatment (Class I reliability); new facilities; equalization of industrial wastewaters | Discharge to subsurface waters, Hidden River Cave system downstream from the confluence of East and South Branches | This provides a comparison between construction of a new treatment plant and upgrading the existing facilities |
| **Horse Cave** | HC-4 | Secondary treatment (Class III reliability); upgraded existing facilities; equalization of industrial wastewaters | Surface discharge to the Green River | This appears to represent the most environmentally sound local solution for Horse Cave |
| **Munfordville** | MN-1 | Secondary treatment (w/no solids handling) for existing service area<br>On-lot systems for sections of community outside the service area | Surface discharge to the Green River<br>Soil absorption systems (conventional & alternate) | The possibility of not expanding the present Munfordville collection system requires further evaluation |
| **Munfordville** | MN-2 | Secondary treatment (w/ solids handling) for entire Munfordville community | Surface discharge to the Green River | Providing sewerage service to all the Munfordville community should be fully evaluated |

# TABLE II-5 JOINT WASTEWATER TREATMENT AND/OR DISPOSAL OPTIONS

| Population Centers in Joint Effort | Option Identification | Description of Conveyance and Treatment | Disposal Method and Location | Reason for Further Evaluation |
|---|---|---|---|---|
| **Staging Area**<br>**Park City**<br>**Cave City**<br>**Horse Cave** | (SA-PC-CC-HC)<br>1, 2 & 3 | Conveyance of wastewaters: Staging area to Park City to Cave City to Horse Cave<br>Secondary treatment (Class III reliability) | Surface water discharge Green River near Lawler Bend | A regional approach to wastewater treatment eliminates subsurface discharges in the area. |
| **Park City**<br>**Staging Area**<br>**(Rt. 70 Development)**<br>**Cave City**<br>**Horse Cave** | (PC-SA-CC-HC)<br>1, 2 & 3 | Conveyance of wastewaters: Park City to Staging Area to Cave City to Horse Cave. (Rt. 70 development west of Toohey Ridge to Staging Area, east of Toohey Ridge to Cave City)<br>Secondary treatment (Class III reliability) | Surface water discharge to Green River near Lawler Bend | Not only does this regional approach to wastewater treatment eliminate subsurface discharges in the area, but this option provides service to the Rt.70 development area between Cave City and the Staging Area. |
| **Park City**<br>**Cave City**<br>**Horse Cave** | (PC-CC-HC)<br>1, 2 & 3 | Conveyance of wastewaters: Park City to Staging Area to Horse Cave<br>Secondary treatment (Class III reliability) | Surface water discharge to Green River near Lawler Bend | This provides separation of municipal and National Park alternatives (ease of administration) and still provides for elimination of municipal subsurface discharges. |
| **Staging Area**<br>**(Rt. 70 Development)**<br>**Cave City**<br>**Horse Cave** | (SA-CC-HC)<br>1, 2 & 3 | Conveyance of wastewaters: Staging Area to Cave City to Horse Cave (Rt. 70 Development west of Toohey Ridge to Staging Area, east of Toohey Ridge to Cave City)<br>Secondary treatment (Class III reliability) | Surface water discharge to Green River near Lawler Bend | This provides for elimination of Cave City - Horse Cave subsurface discharges and provides for service to the Staging Area and Rt. 70 development. If Park City chooses local treatment, this appears to be an environmentally favorable method for handling the additional population centers. |
| **Cave City**<br>**Horse Cave** | (CC-HC) 1 | Conveyance of wastewaters; Cave City to Horse Cave<br>Secondary treatment (Class III reliability) | Subsurface discharge to Hidden River Cave downstream from the confluence of the East and South branches | Provide a baseline cost estimate for minimum treatment for Cave City-Horse Cave. |
| **Cave City**<br>**Horse Cave** | (CC-HC)<br>2, 5 & 7 | Conveyance of wastewaters: Cave City to Horse Cave<br>Secondary treatment (Class III reliability) | Seasonal discharge methods. Spray irrigation at Horse Cave during dry months. Subsurface discharge to Hidden River Cave downstream from the confluence of the East and South Branches during wet months | This provides a cost comparison, land application vs. conveyance to Green River. Option still provides for elimination of subsurface discharge during base flow. |
| **Cave City**<br>**Horse Cave** | (CC-HC)<br>3, 6 & 8 | Conveyance of wastewaters: Cave City to Horse Cave<br>Secondary treatment (Class III reliability) | Surface water discharge to Green River near Lawler Bend | This disposal option provides a means for eliminating the largest municipal subsurface discharges. |
| **Cave City**<br>**Horse Cave** | (CC-HC) 4 | Conveyance of wastewaters: Cave City to Horse Cave<br>Advancedsecondary treatment (Class I reliability) | Subsurface discharge to Hidden River Cave downstream from the confluence of the East and South Branches | Advanced secondary treatment (Class I reliability) is compared with conveyance to Green River or seasonal spray irrigation. |

## TABLE II-5 (Cont'd.) JOINT WASTEWATER TREATMENT AND/OR DISPOSAL OPTIONS

| **Population Centers in Joint Effort** | Option Identification | Description of Conveyance and *Treatment | Disposal Method and Location | **Reason for Further Evaluation** |
|---|---|---|---|---|
| **Park City**<br>**Cave City** | (PC-CC) 1 | Conveyance of wastewaters: Park City to Cave City<br>Secondary treatment (Class III reliability) | Seasonal discharge methods: Spray irrigation at Cave City during dry months. Subsurface discharge at existing Cave City site during wet season | **This provides a comparison for spray irrigation and advanced secondary treatment and eliminates Cave City base flow discharge.** |
| **Park City**<br>**Cave City** | (PC-CC) 2 & 3 | Conveyance of wastewaters: Park City to Cave City<br>Advanced secondary treatment (Class I reliability) | Subsurface discharge at existing Cave City site | **The 201 plan indicates this option is favorable.** |
| **Staging Area**<br>**(Rt. 70 Development)**<br>**Cave City** | (SA-CC) | Conveyance of Wastewaters: Staging Area to Cave City (Rt. 70 development west of Toohey Ridge to Staging Area, east of Toohey Ridge to Cave City)<br>Secondary treatment (Class III reliability) | Seasonal discharge methods: Spray irrigation during dry months. Subsurface discharge at existing Cave City site during wet season | **Provides a method for serving the Rt. 70 Development area and Staging Area and eliminates Cave City base flow discharge.** |

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* **Treatment** refers to the treatment level to be attained before discharge or spray irrigation without regard to the method of achieving the **treatment**. Specific methods are presented in alternatives evaluation and account for the different options with the same treatment. (eg.(SA-PC-CC-HC)1, 2 & 3).

water and solids from homes by gravity to central collection facilities for treatment or pumping to higher elevations. The size and slope of gravity sewers is based on carrying the design hydraulic load at velocities sufficient to prevent deposition of solids. For this reason, deep excavations resulting in high construction costs especially in areas with shallow bedrock, are required in locations where the natural slope is inadequate to maintain sufficiently high velocities. Besides this, deep excavation requires deep manholes, expensive to construct and a hindrance to sewer operation and maintenance (O&M). Another disadvantage is that in hilly terrain, several pump stations may be required.

In both Park City and the unsewered portions of Munfordville, the terrain is very irregular with small drainage areas due to karst sinks. In addition shallow bedrock hinders excavation. There are alternative wastewater collection systems that may have an application in these areas. Pressure sewers and vacuum sewers are installed at minimum depths (below frost levels) and conform to the contour of the land, eliminating the need for deep excavation and manholes. (Since there are too few operating vacuum sewer systems to consider this a proven technology, only low pressure sewers are further evaluated.)

In the operation of a low pressure sewer system, wastewater from individual or groups of residences and/or businesses is pumped to PVC force mains by two methods. The most widely used method is the grinder pump (GP system). The second method involves treating the wastewater with a septic tank and effluent pumping (STEP system) to the low pressure collection system via a sump pump.

Low pressure sewers are evaluated for possible use in the unsewered areas of Munfordville as well as in Park City as part of the alternative evaluation. Since Cave City and Horse Cave have existing conventional systems, no evaluation of alternative collection systems is performed.

## 4. IDENTIFICATION OF GENERAL TREATMENT SYSTEM ALTERNATIVES

The following is a discussion of the types of treatment systems and processes to be evaluated further in this EIS.

### Physical-Chemical Systems

Physical chemical (P-C) methods were originally applied to municipal treatment plants as a tertiary treatment step to improve secondary biological effluent quality. The principal processes included chemical co-agulation, filtration, and activated carbon adsorption for residual soluble organics removal. Several advantages have been noted to this system, however many of the advantages are considered to have little applicability in the study area. For this reason, and also because treatment costs are high per volume treated based on the current economy, no consideration is given to evaluating a purely physical-chemical treatment system.

The possibility of the addition of a tertiary filtration step following secondary biological treatment is considered by the 201 consultant for local disposal at Park City and for discharge to the Green River from Horse Cave. This physical process may be added at a later date if required. At this time, however, it does not appear necessary. For treatment/disposal options involving upgrading existing plants or construction of new treatment facilities biological treatment systems are considered adequate.

## Biological Wastewater Treatment Systems

Biological wastewater treatment systems used for secondary treatment of municipal wastewaters generally consist of solids removal by screening and primary sedimentation followed by a biological process which uses a mixed culture of micro-organisms to convert organic wastes to cellular material by biochemical oxidation. The excess cellular material is removed by sedimentation following the biological treatment process, generating a waste sludge which must be stabilized and disposed. Advanced levels of treatment (further BOD reduction and nitrification) may be accomplished by the addition of a second biological process unit.

There are two types of biological processes used in these treatment steps, suspended growth process (e.g. various activated sludge processes) and fixed growth processes (e.g. trickling filters and rotating biological contractors). Suspended growth or fixed growth processes may be used separately or in combination to provide secondary or advanced levels of treatment. The specific processes to be used to accomplish levels of treatment required by different alternatives are selected in the alternatives evaluation. The selections are based on the following criteria:

1. Process reliability
2. Mechanical reliability
3. Operational Ease
4. Energy Consumption
5. Process stability
6. Design flexibility
7. Construction and operating costs

## 5. NON-STRUCTURAL WASTEWATER MANAGEMENT SYSTEMS

### Optimum Use of Existing Facilities

Because the towns of Horse Cave, Munfordville and Cave City have substantial investment in their respective treatment facilities, consideration should be given to maximizing use of these existing facilities in future wastewater treatment plans. Therefore, this discussion of optimum use deals with maximizing use of existing facilities in the study area to minimize construction of new facilities since none of the existing wastewater treatment plants are considered adequate to handle future wastewater flows and loadings with only operations improvements.

Munfordville - All alternative service configurations developed for the study area provide for local wastewater treatment and disposal at Munfordville. Expansion of the existing Munfordville sewerage system, which serves about half of the Munfordville area, is one of two wastewater treatment/disposal options considered. However, the Munfordville year 2000 wastewater flow projection of 120,000 gpd is for the entire Munfordville area, indicating that even if the system is expanded, the existing 150,000 gpd extended aeration facility appears to be adequate to continue to serve the area. The 150,000 gpd capacity also provides some reserve hydraulic capacity for infiltration/inflow. Both options, therefore, provide for full utilization of the existing Munfordville plant to provide secondary treatment. There are, however, improvements necessary for future operations (201 Plan), including disinfection facilities and, if wastewater loads approach design capacity, solids (sludge) handling facilities.

Cave City - Even with optimum performance, the existing Cave City treatment plant is only expected to be capable of producing an effluent BOD of approximately 50 ppm due to strong influent waste loads (201 Plan). The plant is incapable of meeting even secondary treatment levels, therefore use of the plant to provide complete treatment is not considered a viable alternative. However, the 201 Facilities Plan draft sites three alternative uses to be considered:

1. Use of the clarifiers as wet-wells, and aeration and chlorination basins for pre-treatment before pumping.

2. Operating the existing facilities to maximum potential and pumping the effluent to a central facility for additional treatment and disposal.

3. Operating the existing facilities to maximum potential and adding an additional treatment step at the present site.

Horse Cave - Information in the 201 Facilities Plan draft indicates that even with adequate industrial pre-treatment, plant repairs and optimum operations, the existing facilities at Horse Cave are only capable of producing an effluent BOD concentration of approximately 40 ppm which exceeds secondary treatment standards. Therefore, as in the case of the Cave City plant, use of the existing facilities to provide complete treatment is not considered a viable alternative. There are, however, alternative uses which are to be further evaluated:

1. Operating the existing facilities (with repairs and industrial pre-treatment) to maximum potential and pumping the effluent to a joint treatment facility for additional treatment and disposal.
2. Operating the existing facilities (with repairs and industrial pre-treatment) to maximum potential as part of an upgraded plant to serve Horse Cave.

## Flow and Waste Reduction

The use of water conservation and flow reduction techniques is an important non-structural technique. Where a treatment plant is already overloaded, a reduction in wastewater flows could significantly improve wastewater treatment.

The reduction of flows could have several effects upon a community's wastewater system. First, treatment could be improved with reduced flows. Secondly, the community could possibly avoid the cost of constructing a new or expanded treatment plant with the reduction of flows into the existing plant or prolong the design life of plants presently being designed or constructed.

Per capita water consumption throughout the Mammoth Cave study area is near or below average* when only considering residential and non-motel commercial water consumption. Estimated 1980 per capita consumption for Park City is 50 gpcd (189 liters pcd); Cave City, 60 gpcd (227 liters pcd); Horse Cave, 50 gpcd (189 liters pcd); and 60 gpcd (227 liters pcd) for Munfordville.

It is unlikely that these demands can be substantially reduced. However, estimates of future per capita consumption used in developing water consumption projections do not reflect the traditional rate of increase, but rather increase more slowly in an attempt to account for conservation trends.

Flow reduction techniques could be expected to have a significant impact on motel and tourist-related commercial water consumption as well as industrial water consumption where controls may result in substantial economic benefits. In the towns of Cave City and Horse Cave, residential and non-motel commercial consumption in the summer months is less than one-half the total water consumption. This situation is expected in Park City as tourism grows. Major reductions in water demands could prolong the design life of planned wastewater treatment facilities to serve these areas.

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* Comparison of estimated per capita consumption with normal water consumption figures - Fair, Geyer and Okun, Water Supply and Wastewater Removal, Vol. 1, pp.5-13, 1966.

There are several flow reduction alternatives available that would be suitable for use in the Mammoth Cave area. These include:

1. Water Use Reduction
    a. Plumbing Codes
    b. Flow Control Devices
    c. Educational Programs
2. Water and Wastewater Pricing
3. On-Site Disposal of Wastewater

## Land Use and Development Controls

Land use controls which provide for some order to development may limit potential adverse impacts on water quality (and other environmental amenities) from uncontrolled growth. Limiting the size of motels and/or campgrounds in areas where subsurface discharges of wastewater might severely impact cave waters is one example of a specific application of this type of control in the Mammoth Cave area.

Land use controls are also important in areas of interceptor construction. Many times a cost-effective method of transporting wastewaters is abandoned for fear of uncontrolled growth near the interceptor line, especially if the interceptor is to pass through an environmentally sensitive area. This is not a very satisfactory approach to land use planning since the decision on interceptor location is actually determining the area of development. An effective land use program could end this type of indirect decision making by placing the land use decisions directly in the hands of local governments.

In order to effectively plan and manage land use there are a variety of land management tools and techniques that are available to the various counties and municipalities and the study area. These techniques are:

- comprehensive plans
- zoning ordinances
- subdivision and land development regulations

- Easements
- Fee Simple Aquisition of Land
- staged growth policies
- conservation zoning district
- model zoning ordinances

## Industrial Wastewater Management

The adverse effects of industrial wastewaters (Ken Dec, Inc., and Hart County Creamery, Inc.) on operations at the Horse Cave treatment plant are well-documented. Electroplating wastewaters, which account for approximately one half of the total hydraulic load to the plant, have been toxic to the biological processes because of their high (and variable) concentrations of heavy metals and pH extremes. Low pH levels are suspected as the cause of damage to plant equipment. Wastewaters from the cheese and whey plants of Hart County Creameries also adversely affect the biological processes by discharging wastewaters with extreme pH variations, caused by the use of acid and alkali cleaners for washdown and also the acidic nature of some whey wastes. In addition, spills and washdown result in temporary discharges of extremely high BOD which also may adversely affect the biological processes. Since both of these facilities are located near the treatment plant, there is little dilution of industrial wastewaters before entering the plant.

Recommendations in the 201 Wastewater Facilities Plan draft for minimizing adverse effects of industrial wastewaters in the plant, call for action on the part of both industries, and the town of Horse Cave.

Horse Cave - Three immediate steps recommended by the 201 Plan Draft with respect to industrial wastewater management to improve present plant operations are:

1. Install a recording pH meter with an alarm system for monitoring the plant influent
2. Negotiate with Ken Dec, Inc. to obtain an agreement for providing improved and more consistent pre-treatment operations

3. Pass an interim use ordinance to limit the metals in industrial discharges as follows:

| | Recommended Standard |
|---|---|
| Total Chromium | 1 ppm |
| Hexavalent Chromium | .25 ppm |
| Copper | .2 ppm |
| Nickel | 1.0 ppm |
| Zinc | .2 ppm |
| pH | 6.5-9 ppm |
| Suspended Solids | - |
| Total Cyanide | 0.2 ppm |
| Free Cyanide | - |
| Total Metals | 2.5 ppm |

Additionally, the 201 Plan will evaluate the option of having Ken Dec's waste routed directly to the effluent pump station after pretreatment/equalization.

Another recommendation to the City of Horse Cave, is the construction of a 24-hour aerated equalization basin. Wastewater from the basin would by-pass the existing secondary treatment facilities and be treated in a final step either at local or joint treatment facilities, assuring some consistent treatment, and providing for use of existing facilities as a first treatment step without hydraulic overloading.

Ken Dec, Inc. - Recommended steps by the 201 Plan are:

1. Diversion of wastes to a temporary holding basin in case of spill or lapse in the pre-treatment process

2. Provisions for additional treatment of improperly treated wastes that reach the basin.

These steps would improve operations of the Ken Dec pretreatment facilities to meet more stringent standards than required by EPA pre-treatment. The 201 Plan Draft indicates that even if EPA standards are met, concentrations of some metals, after Ken Dec's 1:1 dilution with non-metal bearing wastes, would remain high enough to be toxic to some biological treatment processes based on results of toxicity studies published by EPA.

Hart County Creamery, Inc. - The 201 Plan recommendations for improved pre-treatment are:

1. Install an aerated equalization basin for cheese plant wastes holding a minimum of 25,000 gallons to be discharged over a minimum of a 18-hour period.

2. Install better curbing around loading and unloading areas and pipe wastes and spills from these areas to equalization facilities.

3. Install recording pH meters with alarms on equalization facilities at both the cheese and whey plants.

4. Install automatic pH adjustment at the whey plant equalization facility.

5. Pipe drains from the whey plant loading platform to the proposed cheese plant equalization basin.

6. Make provision for storing spills in the equalization basin by temporarily by-passing the equalization basin.

Additional comments and recommendations were made in this EIS for industrial wastewater management in the City of Horse Cave; Ken Dec, Inc.; and Hart County Creameries, Inc., including:

1. Adoption of a stringent and enforceable sewer use ordinance to protect public wastewater facilities.

2. Development of a holding basin and additional treatment to help protect against spills and operations problems at Ken Dec, Inc. It is also recommended that a spill and accident prevention plan be developed by Ken Dec, Inc.

3. Investigation of methods for re-use of process wastewaters by Ken Dec, Inc.

4. Transportation of wastes to the 24-hour equalization basin recommended in the 201 Plan, should be by way of a force main to pump wastes directly from Ken Dec to the basin. It is recommended, therefore, that these wastes be entirely industrial.

## PART C. WASTEWATER COLLECTION, CONVEYANCE, AND TREATMENT SYSTEMS

### 1. COLLECTION SYSTEMS

Construction of new wastewater collection facilities to serve Park City and the expansion of the Munfordville wastewater collection system to serve the remainder of that municipality are the only collection systems considered in any local or joint treatment/disposal option. Although the 201 Plan provides for some expansion of the Cave City and Horse Cave systems, these expansions are expected to occur regardless of the option selected. The proposed collection facilities at Park City and Munfordville, however, are critical elements of the options in which they are included.

Because of the hilly terrain and shallow rock generally found in karst areas, low pressure sewers may be a favorable alternative to conventional wastewater collection systems. In Park City, however, it appears that the terrain is such that a conventional gravity collection system may be constructed to serve the main community. (Pumping would be required to extend service to the Southern States feed mill located on Rt. 31W.) This system is displayed in Figure II-1. The net present worth for either system is estimated to be approximately $1.8 million. Because the conventional system is considered much more reliable and since local annual costs are substantially less, the conventional system presented in the 201 Plan is the recommended collection system and is used for purposes of costing and evaluating different options that include wastewater systems for Park City.

Another wastewater collection system considered for Park City is the small community system to serve only the more densely developed business section. This system is included as part of an on-lot option for Park City to collect and transport wastewater to a community soil absorption site south of the L&N railroad. The most appropriate choice for this collection system appears to be a low pressure sewer STEP system. With a STEP system, wastewater is treated by individual septic tanks and then pumped into the low pressure system by sump pumps. The STEP system not only provides the needed pressure to convey the wastewater to the disposal site, but also provides for treatment of the wastewater so that it may be distributed directly into the absorption system. The proposed low pressure sewer service area is indicated in Figure II-1.

One local treatment/disposal option for Munfordville includes expansion of the Munfordville wastewater collection system to serve the entire municipality. The conventional collection system expansion proposed in the 201 facilities plan requires construction of four new pump stations because of the hilly terrain. Because of the additional expenses associated with the pump stations, the conventional system appears to be substantially more costly than the low pressure system. Because of apparent economic advantages, the low pressure system is the recommended collection technique to be used for costing and evaluation of this option. The proposed wastewater collection system expansion is indicated in Figure II-2.

## 2. CONVEYANCE SYSTEMS

Conveyance facilities include pump stations, force mains and gravity interceptors and are an integral part of joint wastewater treatment/disposal options. Because of the relatively small volumes of wastewater that are pumped between population centers, all pump stations are considered to be package-type for costing purposes. Force main and gravity interceptor routes between the population centers are assumed to be identical as those identified in the 201 facilities plan. For treatment disposal options that include pumping wastewater to the Green River, however, the force main route from Horse Cave to the Green River is different than that proposed by the 201 facilities plan. Even though the length of the route proposed by the 201 Plan is much longer, the total dynamic head the pumps must overcome is estimated to be approximately forty-five feet less. How-

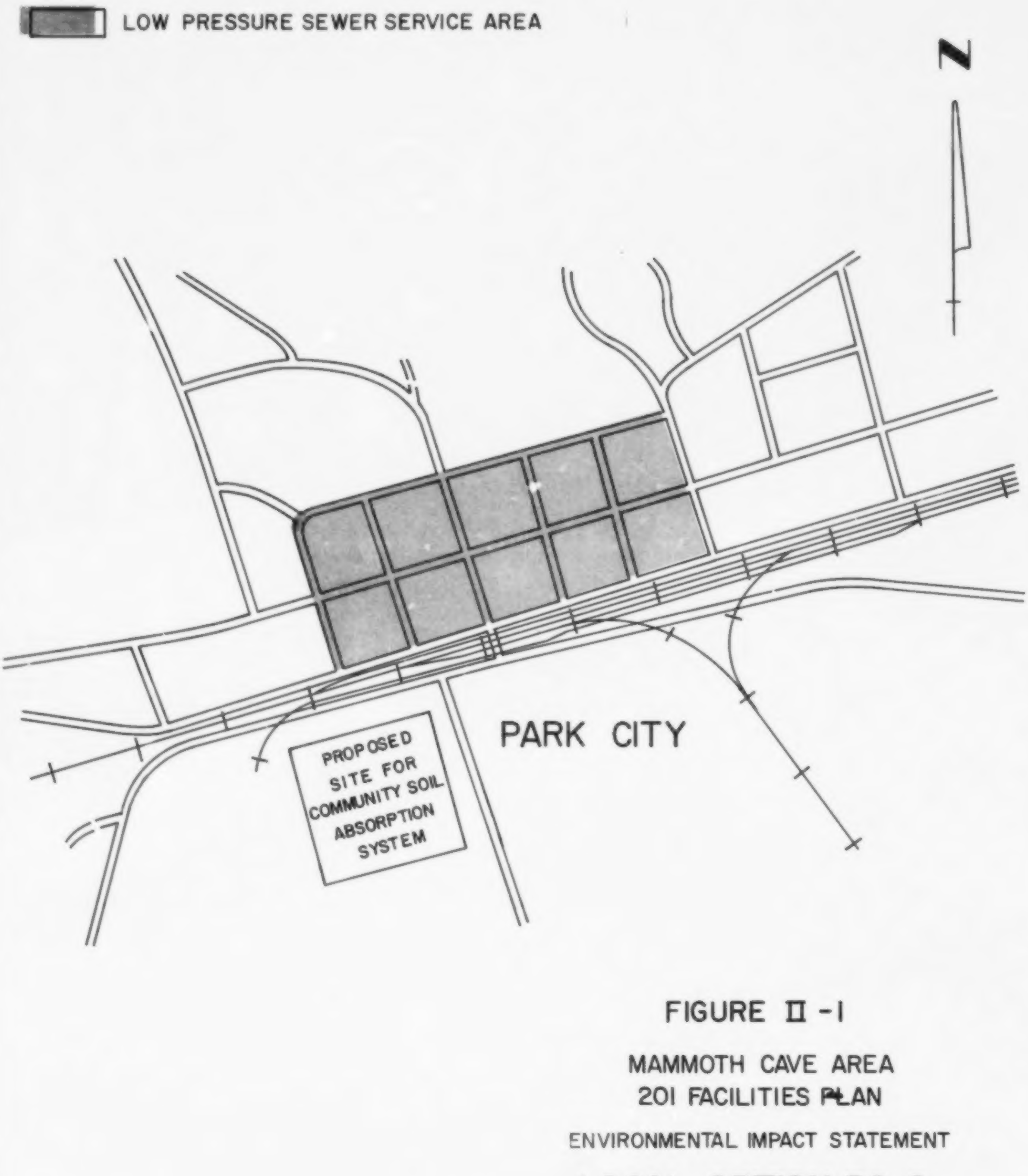
▨ LOW PRESSURE SEWER SERVICE AREA
N
PARK CITY
PROPOSED SITE FOR COMMUNITY SOIL ABSORPTION SYSTEM

FIGURE II -1

MAMMOTH CAVE AREA
201 FACILITIES PLAN

ENVIRONMENTAL IMPACT STATEMENT

LOCAL OPTION PC-2
COMMUNITY LOW PRESSURE SEWER
AND SOIL ABSORPTION SITE

600 300 0 600 1200
Scale In Feet

U.S. Environmental Protection Agency
Region IV Atlanta, Georgia

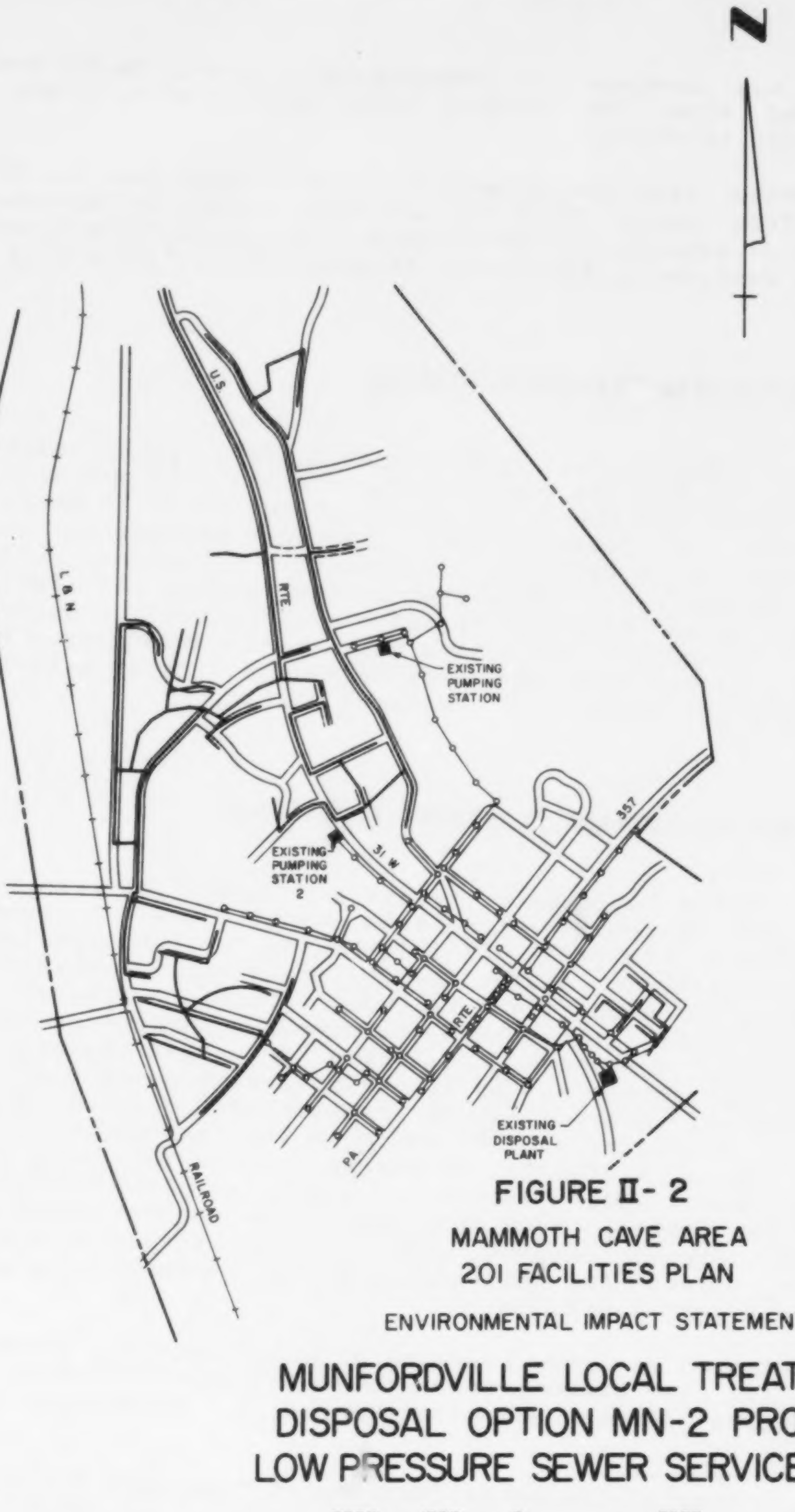
N
U.S.
RTE.
31 W
L & N
RAILROAD
357
PA
EXISTING PUMPING STATION
EXISTING PUMPING STATION 2
EXISTING DISPOSAL PLANT
2000
1000
0
2000
4000
Scale in Feet

FIGURE II- 2

MAMMOTH CAVE AREA
201 FACILITIES PLAN

ENVIRONMENTAL IMPACT STATEMENT

## MUNFORDVILLE LOCAL TREATMENT/ DISPOSAL OPTION MN-2 PROPOSED LOW PRESSURE SEWER SERVICE AREA

U.S. Environmental Protection Agency
Region IV Atlanta, Georgia

ever, the savings in pumping costs appear to be insignificant when compared with the project costs associated with the additional construction required.

Other than the alternate route recommended for the outfall force main from Horse Cave to the Green River, no alternative conveyance routes or methods are considered. The conveyance routes are indicated in the Wastewater Management Alternatives, Figure II-3 through II-10.

## 3. WASTEWATER TREATMENT SYSTEMS

All wastewater treatment/disposal options evaluated in the EIS include provisions for specific types of biological treatment systems to provide the levels of treatment indicated in Tables II-4 and II-5. Selection of these specific treatment systems for incorporation into the options is based on consideration of process reliability, mechanical reliability, operational ease, energy consumption, process stability, design flexibility and costs. There are basically two general types of process selections that are required; process selections for new wastewater treatment facilities and process selections for upgrading existing wastewater treatment plants.

### New Wastewater Treatment Facilities

Several wastewater treatment/disposal options include provisions for new wastewater treatment facilities. A summary of these new wastewater treatment facilities and the required levels of treatment is provided in Table II-6. Given the relatively small wastewater flows in the study area, extended aeration activated sludge appears to be the most appropriate wastewater treatment process for use in new wastewater treatment facilities to serve the study area. Although operating costs may be slightly more than other biological processes because of greater energy requirements, overall units costs ($/1000 gal.), including project costs as well as operations costs, are lower than other biological treatment systems for field constructed plants less than 2 mgd,* based on a discount rate of 7.125 percent over the planning period. Even considering field-constructed extended aeration plants versus contact stabilization package plants in the 0.1-1 mgd range, costs for extended aeration systems are competitive based on overall unit costs. **

There are two types of extended aeration processes proposed for use in the Mammoth Cave area wastewater treatment/disposal options, oxidation ditches and aeration basins. Except for the package plants

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* "Small Community Wastewater Treatment Facilities - Biological Treatment System," Henry H. Benjes, Jr., Small Wastewater Treatment Facilities, U.S. EPA, January, 1978, p. 93, Figure 38.

** Ibid

## TABLE II-6 IDENTIFICATION OF NEW WASTEWATER TREATMENT FACILITIES INCLUDED IN LOCAL AND JOINT WASTEWATER TREATMENT/DISPOSAL OPTIONS TO BE EVALUATED

| Location of Proposed New Wastewater Treatment Facilities | Wastewater Source(s) | Level of Treatment Required | Design Flow ($m^3$/day) | Options that Include New Facilities |
|---|---|---|---|---|
| Park City | Park City | Secondary | 0.08 mgd<br>(303) | PC-1, (PC-SA-CC-HC)$^{1-3}$,<br>(PC-CC-HC)$^{1-3}$, (PC-CC)$^{1-3}$ |
| Park City | Park City<br>Staging Area | Secondary | 0.16 mgd<br>(606) | (SA-PC-CC-HC)$^{1-3}$ |
| Staging Area (Chaumont) | Staging Area<br>Rt. 70 Development<br>West of Tookey Ridge | Secondary | 0.105 mgd<br>(398) | (PC-SA-CC-HC)$^{1-3}$, (SA-CC)$^{1}$<br>(SA-CC-HC)$^{1-3}$ |
| Cave City | Cave City | Advanced Secondary | 0.37 mgd<br>(1400) | CC-1 |
| Horse Cave | Horse Cave | Advanced Secondary | 0.53 mgd<br>(2006) | HC-3 |
| Horse Cave | Staging Area<br>Cave City<br>Park City<br>Horse Cave | Secondary | 1.06 mgd<br>(4013) | (SA-PC-CC-HC)$^{3}$ |
| Horse Cave | Staging Area<br>Cave City<br>Park City<br>Horse Cave<br>Rt. 70 Development | Secondary | 1.11 mgd<br>(4202) | (SA-PC-CC-HC)$^{3}$ |
| Horse Cave | Park City<br>Cave City<br>Horse Cave | Secondary | 0.98 mgd<br>(3710) | (PC-CC-HC)$^{2}$ |
| Horse Cave | Staging Area<br>Rt. 70 Development<br>Cave City<br>Horse Cave | Secondary | 1.03 mgd<br>(3899) | (SA-CC-HC)$^{2}$ |
| Horse Cave | Cave City<br>Horse Cave | Advanced Secondary | 0.9 mgd<br>(3407) | (CC-HC)$^{4}$ |
| Horse Cave | Horse Cave<br>Cave City | Secondary | 0.9 mgd<br>(3407) | (CC-HC)$^{5}$, (CC-HC)$^{6}$ |

proposed for the Staging Area and Park City, the oxidation ditch type plant is assumed for costing and evaluation for all new treatment facilities included in the treatment/disposal options. The oxidation ditch system is capable of consistently providing greater than secondary treatment, with effluent BOD generally 10 - 20 mg/l.

## Upgrading Existing Wastewater Treatment Facilities

The existing wastewater treatment facilities at Horse Cave and Cave City are similar processes. According to the 201 Plan each of these plants is capable of producing an effluent $BOD_5$ of approximately 50 mg/l if operated at optimum efficiency. (In Horse Cave this is contingent on adequate pre-treatment of industrial wastewaters). In order to use these facilities in the future, the effluent requires upgrading to meet secondary treatment standards.

There are several wastewater treatment/disposal options evaluated that include provisions for upgrading the existing Horse Cave and Cave City treatment plants. A summary of proposed upgradings is provided in Table II-7. These include local upgrading to provide secondary treatment at each plant as well as joint upgrading by combining the effluents from both existing plants for joint secondary treatment at Horse Cave. Treatment requirements are secondary and advanced secondary.

Since the existing facilities are capable of providing substantial $BOD_5$ removal, it appears that a second stage biological treatment step in series with existing trickling filter processes is the most appropriate method of treatment for upgrading the plant effluents. Although additional trickling filter facilities or other fixed film biological processes could be considered, however, based on cost and reliability considerations, activated sludge is the process of choice. Therefore, for all upgrading options, an activated sludge second stage biological treatment step is the assumed method of upgrading. For local upgrading options at either Horse Cave or Cave City this requires the addition of concrete-lined/earthen aeration basins with mechanical aeration and return sludge pumping. Both plants require additional final settling facilities. General schematics of the proposed processes are provided in Figures II-12 and II-13. (Chapter II, Part G) For joint treatment at Horse Cave, a new activated sludge facility is proposed, however, the plant would include no preliminary treatment facilities. It should be noted that any effluent limitations which require $BOD_5$ limits of less than 20 mg/l will require dual media filters as part of the treatment process.

It is expected that a second stage activated sludge treatment step will provide secondary or advanced secondary treatment depending on the sizing of the aeration facilities. For costing purposes, secondary treatment is assumed to require four hours aeration and advanced secondary six hours aeration.

For wastewater treatment/disposal options that include conveyance from the Staging Area to Cave City and upgrading Cave City facilities

TABLE II-7. IDENTIFICATION OF WASTEWATER TREATMENT PLANT UPGRADINGS INCLUDED IN LOCAL AND JOINT TREATMENT/DISPOSAL OPTIONS TO BE EVALUATED

| Proposed Upgrading | Wastewater Source(s) | Level of Treatment Required | Design Capacity of Upgraded Facilities | Options that Include the Upgraded Facilities |
|---|---|---|---|---|
| Cave City WWTP | Cave City | Secondary | 0.37 mgd (1400 $m^3$/day) | CC-2, (SA-PC-CC-HC)$^{2}$ (PC-CC-HC)$^{3}$, (CC-HC)$^{7 \& 8}$, (PC-CC)$^{1}$ |
| Cave City WWTP | Cave City<br>Staging Area<br>Rt. 70 Development | Secondary | 0.45 mgd* (1703 $m^3$/day) | (SA-CC-HC)$^{3}$, (SA-CC)$^{1}$ |
| Cave City WWTP | Cave City<br>Staging Area<br>Rt. 70 Development<br>Park City | Secondary | 0.53 mgd* (2006 $m^3$/day) | (PC-SA-CC-HC)$^{2}$ |
| Cave City WWTP | Cave City | Advanced Secondary | 0.37 mgd (1400 $m^3$/day) | CC-3, (PC-CC)$^{2}$ |
| Horse Cave WWTP | Horse Cave | Secondary | 0.53 (2006 $m^3$/day) | HC-2, HC-4, (SA-PC-CC-HC)$^{2}$, (PC-SA-CC-HC)$^{2}$, (PC-CC-HC)$^{3}$, (CC-HC)$^{7 \& 8}$ |
| Horse Cave WWTP | Horse Cave | Advanced Secondary | 0.53 (2006 $m^3$/day) | HC-1 |
| Horse Cave & Cave City WWTP's in Joint Upgrading | Horse Cave<br>Cave City<br>Park City<br>Staging Area | Secondary | 1.06 mgd* (4013 $m^3$/day) | (SA-PC-CC-HC)$^{1}$ |
| Horse Cave & Cave City WWTP's in Joint Upgrading | Horse Cave<br>Cave City<br>Park City<br>Staging Area<br>Rt. 70 Development | Secondary | 1.11 mgd* (4202 $m^3$/day) | (PC-SA-CC-HC)$^{1}$ |
| Horse Cave & Cave City WWTP's in Joint Upgrading | Park City<br>Cave City<br>Horse Cave | Secondary | 0.98* (3710 $m^3$/day) | (PC-CC-HC)$^{1}$ |
| Horse Cave & Cave City WWTP's in Joint Upgrading | Staging Area<br>Rt. 70 Development<br>Cave City<br>Horse Cave | Secondary | 1.03* (3899 $m^3$/day) | (SA-CC-HC)$^{1}$ |
| Horse Cave & Cave City WWTP's in Joint Upgrading | Horse Cave<br>Cave City | Secondary | 0.9 (3407 $m^3$/day) | (CC-HC)$^{1, 2}$ |

*Hydraulic capacity is provided in the secondary treatment step for treated and raw wastewaters from the Staging Area, Rt. 70 development, and in some cases, Park City. The existing treatment plants at Horse Cave and Cave City are expected to be operated at optimum efficiency and continue to treat only wastewaters generated in their respective service areas. Under upgrading plans the existing Cave City facility is expected to provide treatment for 0.37 mgd; the existing Horse Cave facility 0.28 mgd since Ken Dec wastewaters are to be treated only in the secondary treatment step.

to provide secondary treatment, the sizing of the activated sludge second stage treatment system includes hydraulic capacity for wastewaters from the Staging Area line. This is because raw wastewater from development along Rt. 70 east of Toohey Ridge is to be mixed with treated wastewater from the Staging Area. It is estimated that this water will have a BOD of about 50 mg/l and therefore not require preliminary treatment. Therefore, the existing Cave City facilities will provide preliminary treatment for only Cave City wastewater. Sizing of the joint upgraded treatment facilities includes hydraulic capacity for Horse Cave, Cave City and any other population centers in the option since wastewaters from all population centers are combined at Cave City prior to conveyance to Horse Cave.

## PART D. LOCAL AND JOINT WASTEWATER/DISPOSAL OPTIONS

### 1. LOCAL WASTEWATER TREATMENT AND DISPOSAL OPTIONS

Options for providing local wastewater treatment and disposal are presented and described in Table II-8. With the exception of the Staging Area, at least two local treatment options are considered for each population center. In order that local treatment and disposal options be incorporated in wastewater management alternatives, a recommended local treatment option is selected for each population center. The selection of recommended local treatment options is based on cost, environmental and operability evaluations.

### 2. JOINT TREATMENT/DISPOSAL OPTIONS

The combinations of study area population centers considered appropriate for joint treatment and/or disposal, because of either potential economic or environmental advantages, are presented in Table II-9. Wastewater treatment and disposal options developed for each of these seven joint treatment/disposal combinations are presented in this Table. In order to incorporate these joint treatment/disposal combinations into the wastewater management alternatives, a recommended option is selected for each combination. The recommendations are based on cost, environmental and operability evaluations.

The geographical configuration of the study area population centers is not particularly well-suited for typical regional wastewater treatment facilities where wastewater from several communities is collected and conveyed to a central treatment plant for treatment and disposal. These types of facilities are generally appropriate for communities located close together and generating relatively large volumes of wastewater. In the Mammoth Cave Study Area, to include Park City and/or the Staging Area with a joint treatment/disposal project with Cave City and Horse Cave requires pumping small volumes of wastewater relatively long distances. The problem associated with

## TABLE II-8
## LOCAL WASTEWATER TREATMENT AND DISPOSAL OPTIONS

| Population Center | Option Identification | Description of Treatment | Disposal Method and Location | Proposed Action |
|---|---|---|---|---|
| Park City | PC-1 | Advanced Secondary[1] treatment by extended aeration. | Spray irrigation land application system south of the business section of Park City. | Construction of the following:<br>. Conventional wastewater collection system.<br>. Extended aeration "package" wastewater treatment plant (0.08 mgd).<br>. Spray irrigation system. |
| *Park City | PC-2 | Septic tank/soil absorption systems. Individual systems to serve homes and business establishments that presently discharge directly to groundwater. A community soil absorption system to serve the business section of Park City where individual systems are not feasible. | Land application by soil absorption systems in soils in and around Park City. | Construction of the following:<br>. Conventional and alternate on-lot wastewater treatment and disposal systems,<br>. Small community low pressure sewer wastewater collection system to collect and convey wastewater from individual septic tanks to a community soil absorption system. |
| *Staging Area | SA-1 | Composting waterless toilets septic tank/absorption system for greywater from hand-washing, etc. | Land spreading of composted wastes. Land application by soil absorption for freywater. | Installation of the following:<br>. One hundred fifty composting toilets.<br>. Septic tank and greywater roughing filter treatment system.<br>. Soil absorption system. |
| Horse Cave | HC-1 | Advanced secondary treatment by upgrading existing Horse Cave wastewater treatment plant. (Class I reliability). Equalization for industrial wastewaters. | Discharge to Hidden River Cave at a new site downstream from the confluence of the east and south branches. | . Make necessary repairs to existing facilities.<br>. Addition of duplicate treatment units for reliability and primary clarifier, trickling filter, secondary clarifier and heated anaerobic digester.<br>. Addition of activated sludge second-stage biological treatment system.<br>. Construction of a new outfall to Hidden River Cave.<br>. Construction of industrial wastewater handling facilities. |
| Horse Cave | HC-2 | Secondary treatment by upgrading existing Horse Cave wastewater treatment plant. (Class III reliability). Equalization for industrial wastewaters. | Land application during the dry season and subsurface discharge to Hidden River Cave at a new site downstream from the confluence of the east and south branches. | . Make necessary repairs to existing facilities.<br>. Addition of activated sludge second-stage biological treatment system and a secondary clarifier.<br>. Construction of a land application system.<br>. Construction of a new outfall to Hidden River Cave.<br>. Construction of industrial wastewater handling facilities. |
| Horse Cave | HC-3 | Advanced Secondary treatment by extended aeration (Class I reliability). Equalization for industrial wastewater. | Discharge to Hidden River Cave at a new site downstream from the confluence of the east and south branches. | . Abandon the existing Horse Cave wastewater treatment facility.<br>. Construction of a 0.53 mgd oxidation ditch extended aeration facility. |

[1] Secondary treatment is defined by the EPA as 30 mg/l $BOD_5$ and 30 mg/l TSS. However, extended aeration is expected to provide a higher quality effluent. (10-20 mg/l $BOD_5$ and 20-30 mg/l TSS)

*Option to be included in wastewater management alternatives

TABLE II-6 (Cont'd.)
LOCAL WASTEWATER TREATMENT AND DISPOSAL OPTIONS
(Continued)

| Population Center | Option Identification | Description of Treatment | Disposal Method and Location | Proposed Action |
|---|---|---|---|---|
| *Horse Cave | HC-4 | Secondary treatment by upgrading existing Horse Cave wastewater treatment plant. (Class III reliability). Equalization for industrial wastewaters. | Discharge to the Green River near Lawler Bend via force main. | . Make necessary repairs to existing facilities.<br>. Addition of activated sludge second-stage biological treatment system and a secondary clarifier.<br>. Construction of pumping station and force main to convey treated wastewater to the Green River.<br>. Construction of Industrial wastewater handling facilities. |
| Cave City | CC-1 | Advanced Secondary treatment by extended aeration (Class I reliability). | Discharge to subsurface at the existing site tributary to the Hidden River Cave system. | . Abandon the existing Cave City wastewater treatment plant.<br>Construction of a new 0.37 mgd oxidation ditch extended aeration facility. |
| Cave City | CC-2 | Secondary treatment by upgrading existing Cave City wastewater treatment facilities. (Class III reliability). | Land application during the dry season and subsurface discharge at the existing site during wet season. | . Make necessary repairs to existing facilities.<br>. Conversion of anaerobic digester to aerobic operation<br>. Addition of an activated sludge second-stage biological treatment system and a secondary clarifier.<br>. Construction of a land application system. |
| *Cave City | CC-3 | Advanced Secondary treatment by upgrading existing Cave City facilities. (Class I reliability) | Discharge to subsurface at the existing site tributary to the Hidden River Cave system. | . Make necessary repairs to existing facilities.<br>. Addition of duplicate treatment units for reliability; primary clarifier, trickling filter, secondary clarifier and heated anaerobic digester.<br>. Addition of activated sludge second-stage biological treatment system.<br>. Construction of a new outfall to Hidden River Cave.<br>. Construction of industrial wastewater handling facilities. |
| *Munfordville | MU-1 | Secondary treatment by Munfordville extended aeration plant for existing wastewater collection service area.<br>On-lot septic tank/soil absorption wastewater treatment for homes and businesses outside the existing wastewater collection service area. | Discharge to the Green River via existing outfall.<br>Land application by soil absorption. | . Construction of conventional and alternate on-lot wastewater treatment and disposal systems. |
| Munfordville | MU-2 | Secondary treatment by existing Munfordville extended aeration facility with additional solids handling facilities. | Discharge to the Green River via existing outfall. | . Construction of a low pressure sewer system to expand wastewater collection service to the entire municipal population.<br>. Construction of aerobic digester and sludge drying beds. |

[1] Secondary treatment is defined by the EPA as 30 mg/l $BOD_5$ and 30 mg/l TSS. However, extended aeration is expected to provide a higher quality effluent. (10-20 mg/l $BOD_5$ and 20-30 mg/l TSS)

*Option to be included in wastewater management alternatives

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## TABLE II-9
## DESCRIPTIONS OF JOINT TREATMENT/DISPOSAL OPTIONS

Joint Treatment Configuration: (SA-PC-CC-HC)

Population Centers: Staging Area
Park City
Cave City
Horse Cave

Option Identification: (SA-PC-CC-HC)1

Conveyance of Staging Area wastewater to Park City wastewater treatment plant by gravity interceptor.

↓

Construction of Park City wastewater collection system; treatment of combined Park City-Staging Area wastewaters by a 0.16 mgd extended aeration plant at Park City; conveyance of Park City treatment plant effluent to Cave City pumping station via force main and gravity interceptor.

↓

First stage biological treatment of Cave City wastewater (0.37 mgd) by optimum use of the existing Cave City wastewater treatment plant; conveyance of combined Cave City-Park City treatment plant effluents from Cave City pump station to regional activated sludge second stage biological treatment at Horse Cave.

↓

First stage biological treatment of Horse Cave wastewater (0.28 mgd since KenDec wastes are not to be included in first stage treatment) by optimum use of the existing Horse Cave wastewater treatment plant. Preliminary treatment of KenDec Wastewater (0.25 mgd) by aerated 24-hour equalization basin. Joint secondary treatment of all wastewaters by a 1.06 mgd activated sludge second stage biological treatment system (Class III reliability); conveyance of treated wastewater to Green River discharge by force main.

Option Identification: (SA-PC-CC-HC)2*

Conveyance of Staging Area wastewater to Park City wastewater treatment plant by gravity interceptor.

*Option to be included in wastewater management alternatives.

↓

Construction of Park City wastewater collection system; treatment of combined Park City-Staging Area wastewaters by a 0.16 mgd extended aeration plant at Park City; conveyance of Park City treatment plant effluent to Cave City pumping station via force main and gravity interceptor.

↓

Secondary treatment of Cave City wastewater (0.37 mgd) by upgraded existing Cave City wastewater treatment facility (Class III reliability, two stage biological treatment); conveyance of combined Cave City-Park City effluents from Cave City pumping station to Horse Cave discharge pumping station.

↓

Secondary treatment of Horse Cave wastewaters (0.53 mgd) by upgraded existing Horse Cave wastewater treatment facility (Class III reliability, two-stage biological treatment including preliminary treatment of KenDec wastewater (.25 mgd) by an aerated 24-hour equalization basin, first stage biological treatment of remaining 0.28 mgd by optimum use of existing treatment plant and secondary treatment by a 0.53 mgd activated sludge second stage biological treatment step); conveyance of combined effluents from all treatment plants to Green River discharge via force main.

Option Identification: (SA-PC-CC-HC)$^3$

Conveyance of Staging Area wastewater to Park City wastewater treatment plant by gravity interceptor.

↓

Construction of Park City wastewater collection system; treatment of combined Park City-Staging Area wastewaters by a 0.16 mgd extended aeration plant at Park City; conveyance of Park City treatment plant effluent to Cave City pumping station via force main and gravity interceptor.

↓

Abandon existing Cave City wastewater treatment facilities for use as a pumping station; conveyance of combined Cave City raw wastewater and Park City treatment plant effluent to regional secondary treatment facility at Horse Cave.

↓

Abandon existing Horse Cave wastewater treatment facilities; preliminary treatment of KenDec wastewater by aerated 24-hour equalization basin; joint secondary treatment of all wastewaters by a 1.06 mgd oxidation ditch treatment plant (Class III reliability); conveyance of regional plant effluent to Green River discharge via force main.

Joint Treatment Configuration: (PC-SA-CC-HC)

Population Centers: Park City
Staging Area (including Rt. 70 development)
Cave City
Horse Cave

Option Identification: (PC-SA-CC-HC)[1]

Construction of Park City collection system; secondary treatment of Park City wastewaters by 0.08 mgd extended aeration wastewater treatment plant; conveyance of Park City treatment plant; conveyance of Park City treatment plant effluent to pumping station at Chaumont via force main.

↓

Gravity conveyance of wastewater from Staging Area to treatment plant site at Chaumont; gravity conveyance from Rt. 70 development west of Tooney Ridge to wastewater treatment plant site at Chaumont; secondary treatment of Staging Area and Rt. 70 development wastewaters by a 0.105 mgd extended aeration facility at Chaumont; conveyance of combined Staging Area-Park City treatment plant effluents to Cave City pumping station by force main followed by gravity interceptor east of Tookey Ridge (additional Rt. 70 wastewater collected by gravity interceptor to Cave City).

↓

First stage biological treatment of Cave City wastewater (0.37 mgd) by optimum use of the existing wastewater treatment plant; conveyance of combined Park City-Staging Area-Rt. 70 and Cave City partially treated wastewaters by force main and gravity interceptor to regional activated sludge second stage biological treatment system at Horse Cave.

↓

First stage biological treatment of Horse Cave wastewater (.28 mgd since KenDec wastes are not to be included in first stage treatment) by optimum use of existing Horse Cave wastewater treatment plant; preliminary treatment of KenDec wastewater (0.25 mgd) by aerated 24-hour equalization basin; joint secondary treatment of all wastewaters by a 1.11 mgd regional activated sludge second stage biological treatment system (Class III reliability); conveyance of treated wastewater to Green River discharge via force main.

Option Identification: (PC-SA-CC-HC)$^{2*}$

Construction of Park City collection system; secondary treatment of Park City wastewaters by 0.08 mgd extended aeration wastewater treatment plant; conveyance of Park City treatment plant; conveyance of Park City treatment plant effluent to pumping station at Chaumont via force main.

↓

Gravity conveyance of wastewater from Staging Area to treatment plant site at Chaumont; gravity conveyance from Rt. 70 development west of Toohey Ridge to wastewater treatment plant site at Chaumont; secondary treatment of Staging Area and Rt. 70 development wastewaters by a 0.105 mgd extended aeration facility at Chaumont; conveyance of combined Staging Area-Park City treatment plant effluents to Cave City pumping station by force main followed by gravity interceptor east of Toohey Ridge (additional Rt. 70 wastewater collected by gravity interceptor to Cave City).

↓

Secondary treatment of treated-raw wastewater mixture from Staging Area (0.185 mgd) and Cave City wastewater (0.37 mgd) by upgraded and expanded existing Cave City wastewater treatment plant (Class III reliability, two stage biological treatment including first stage biological treatment of Cave City wastewater only (0.37 mgd) by optimum use of existing treatment plant and secondary treatment by a 0.56 mgd activated sludge second stage biological treatment step); conveyance of Cave City treatment plant effluent to Horse Cave for joint disposal.

↓

Secondary treatment of Horse Cave wastewaters (0.53 mgd) by upgraded existing Horse Cave wastewater treatment facility (Class III reliability, two-stage biological treatment including preliminary treatment of Ken Dec wastewater (.25 mgd) by an aerated 24-hour equalization basin, first stage biological treatment of remaining 0.28 mgd by optimum use of existing treatment plant and secondary treatment by a 0.53 mgd activated sludge second stage biological treatment step); conveyance of combined Cave City-Horse Cave effluents to Green River discharge via force main.

Option Identification: (PC-SA-CC-HC)$^{3}$

Construction of Park City collection system; secondary treatment of

Park City wastewaters by 0.08 mgd extended aeration wastewater treatment plant; conveyance of Park City treatment plant; conveyance of Park City treatment plant effluent to pumping station at Chaumont via force main.

Gravity conveyance of wastewater from Staging Area to treatment plant site at Chaumont; gravity conveyance from Rt. 70 development west of Toohey Ridge to wastewater treatment plant site at Chaumont; secondary treatment of Staging Area and Rt. 70 development wastewaters by a 0.105 mgd extended aeration facility at Chaumont; conveyance of combined Staging Area-Park City treatment plant effluents to Cave City pumping station by force main followed by gravity interceptor east of Toohey Ridge (additional Rt. 70 wastewater collected by gravity interceptor to Cave City).

Abandon existing Cave City wastewater treatment facilities for use as a pumping station; conveyance of combined Cave City raw wastewater and Staging Area treated-raw wastewater mixture to regional secondary treatment facility at Horse Cave.

Abandon existing Horse Cave wastewater treatment plant; Preliminary treatment of Ken Dec wastewaters by aerated 24-hour equalization basin; joint secondary treatment of all wastewaters by a 1.11 mgd oxidation ditch treatment plant (Class III reliability); conveyance of regional treatment plant effluent to Green River discharge via force main.

Joint Treatment Configuration: (PG-CC-HC)

Population Centers: Park City
Cave City
Horse Cave

Option Identification: (PC-CC-HC)[1]

Construction of Park City wastewater collection system; secondary treatment of Park City wastewater by a 0.08 mgd extended aeration wastewater treatment plant; conveyance of Park City treatment plant effluent to Cave City pump station.

First stage biological treatment of Cave City wastewater (0.37 mgd) by optimum use of the existing wastewater treatment plant; conveyance of combined Park City-Cave City plant effluents to regional activated sludge second stage biological treatment system at Horse Cave for joint treatment.

First stage biological treatment of Horse Cave wastewater (0.28 mgd since Ken Dec wastes are not to be included in first stage treatment) by optimum use of the existing Horse Cave wastewater treatment plant; preliminary treatment of Ken Dec wastewater (0.25 mgd) by aerated 24-hour equalization basin; joint secondary treatment of all wastewaters by a 0.98 mgd activated sludge second-stage biological treatment system (Class III reliability); conveyance of treated wastewater to Green River discharge via force main.

Option Identification: (PC-CC-HC)$^{2}$

Construction of Park City wastewater collection system; secondary treatment of Park City wastewater by a 0.08 mgd extended aeration wastewater treatment plant; conveyance of Park City treatment plant effluent to Cave City pump station.

Abandon the existing Cave City wastewater treatment facilities for use as a pumping station; conveyance of combined Park City effluent and Cave City raw wastewater by force main and gravity interceptor to regional secondary treatment plant at Horse Cave.

Abandon existing Horse Cave wastewater treatment; preliminary treatment of Ken Dec wastewater by aerated 24-hour equalization basin; joint secondary treatment of all wastewaters by a 0.98 mgd oxidation ditch treatment plant (Class III reliability); conveyance of oxidation ditch effluent to Green River discharge via force main.

Option Identification: (PC-CC-HC)$^{3*}$

Construction of Park City wastewater collection system; secondary treatment of Park City wastewater by a 0.08 mgd extended aeration wastewater treatment plant; conveyance of Park City treatment plant effluent to Cave City pump station.

↓

Secondary treatment of Cave City wastewater (0.37 mgd) by upgraded existing Cave City wastewater treatment plant (Class III reliability, two-stage biological treatment); conveyance of combined effluents from Park City and Cave City treatment plants to Horse Cave pumping station by force main and gravity interceptor.

↓

Secondary treatment of Horse Cave wastewaters (0.53 mgd) by upgraded existing Horse Cave wastewater treatment facility (Class III reliability, two-stage biological treatment including preliminary treatment of Ken Dec wastewater (.25 mgd) by an aerated 24-hour equalization basin, first stage biological treatment of remaining 0.28 mgd by optimum use of existing treatment plant and secondary treatment by a 0.53 mgd activated sludge second stage biological treatment step); conveyance of combined Cave City and Horse Cave effluents to Green River discharge via force main.

Joint Treatment Configuration: (SA-CC-HC)

Population Centers: Staging Area (including Rt. 70 development)
Cave City
Horse Cave

Option Identification: (SA-CC-HC)$^1$

Gravity conveyance of wastewater from Staging Area to treatment plant site near Chaumont; gravity conveyance from Rt. 70 development west of Tooney Ridge to the wastewater treatment plant at Chaumong; secondary treatment of Staging Area and Rt. 70 development wastewaters by a 0.105 mgd extended aeration facility at Chaumont; conveyance of Chaumont treatment plant effluent to Cave City pumping station by force main followed by gravity interceptor east of Toohey Ridge; (additional Rt. 70 wastewater collected by gravity interceptor to Cave City.)

↓

First stage biological treatment of Cave City wastewater (0.37 mgd) by optimum use of the existing wastewater treatment plant; conveyance of combined Staging Area-Rt. 70 and Cave City partially treated wastewaters by force main and gravity interceptor to a regional activated sludge second stage biological treatment system at Horse Cave.

↓

First stage biological treatment of Horse Cave wastewater (0.28 mgd since Ken Dec are not to be included in first stage treatment) by optimum use of the existing Horse Cave wastewater treatment plant; preliminary treatment of Ken Dec wastewater by aerated 24-hour equalization basin; joint secondary treatment of all wastewaters by a 1.03 mgd activated sludge second stage biological treatment system (Class III reliability); conveyance of treated wastewater to Green River discharge via force main.

Option Identification: (SA-CC-HC)$^{2}$

Gravity conveyance of wastewater from Staging Area to treatment plant site near Chaumont; gravity conveyance from Rt. 70 development west of Toohey Ridge to the wastewater treatment plant at Chaumont; secondary treatment of Staging Area and Rt. 70 development wastewaters by a 0.105 mgd extended aeration facility at Chaumont; conveyance of Chaumont treatment plant effluent to Cave City pumping station by force main followed by gravity interceptor east of Toohey Ridge; (additional Rt. 70 wastewater collected by gravity interceptor to Cave City.)

↓

Abandon existing Cave City wastewater treatment facilities for use as a pumping station; conveyance of Cave City raw wastewater and Staging Area-Rt. 70 partially treated wastewater to regional secondary treatment plant at Horse Cave by force main and gravity interceptor.

↓

Abandon existing Horse Cave wastewater treatment plant; preliminary treatment of Ken Dec wastewater by aerated 24-hour equalization basin; joint secondary treatment of all wastewaters by a 1.03 mgd oxidation ditch treatment plant; conveyance of oxidation ditch effluent to Green River discharge via force main.

Option Identification: (SA-CC-HC)$^{3*}$

Gravity conveyance of wastewater from Staging Area to treatment plant site near Chaumont; gravity conveyance from Rt. 70 development west of Toohey Ridge to the wastewater treatment plant at Chaumont; secondary treatment of Staging Area and Rt. 70 development wastewaters by a 0.105 mgd extended aeration facility at Chaumont; conveyance of Chaumont treatment plant effluent to Cave City pumping station by force main followed by gravity interceptor east of Toohey Ridge; (additional Rt. 70 wastewater collected by gravity interceptor to Cave City.)

↓

Secondary treatment of treated-raw wastewater mixture from Staging Area (0.105 mgd) and Cave City wastewater (0.37 mgd by upgraded and expanded existing Cave City wastewater treatment plant (Class III reliability, two-stage biological treatment including first stage biological treatment of Cave City wastewater only (0.37 mgd) by optimum use of existing treatment plant and secondary treatment by a 0.48 mgd activated sludge second stage biological treatment step); conveyance of Cave City treatment plant effluent to Horse Cave for joint disposal by force main and gravity interceptor.

↓

Secondary treatment of Horse Cave wastewaters (0.53 mgd) by upgraded existing Horse Cave wastewater treatment facility (Class III reliability, two-stage biological treatment including preliminary treatment of Ken Dec wastewater (.25 mgd) by an aerated 24-hour equalization basin, first stage biological treatment of remaining 0.28 mgd by optimum use of existing treatment plant and secondary treatment by a 0.53 mgd activated sludge second stage biological treatment step); conveyance of combined effluents from Cave City and Horse Cave to Green River discharge via force main.

Joint Treatment Configuration: (CC-HC)

Population Centers: Cave City
Horse Cave

Option Identification: (CC-HC)$^1$

First stage biological treatment for Cave City wastewater by optimum use of the existing wastewater treatment plant; conveyance of Cave City plant effluent to activated sludge treatment facility in Horse Cave.

↓

First stage biological treatment of Horse Cave wastewater (0.28 mgd since Ken Dec wastes not included in first stage treatment) by optimum use of existing facilities; preliminary treatment of Ken Dec wastewater by aerated 24-hour equalization; joint secondary treatment of Cave City and Horse Cave wastewaters by activated sludge second stage biological treatment system; gravity conveyance of treatment plant effluent to Hidden River Cave discharge below the east-south branch confluence.

Option Identification: (CC-HC)$^2$

First stage biological treatment for Cave City wastewater by optimum use of the existing wastewater treatment plant; conveyance of Cave City plant effluent to activated sludge treatment facility in Horse Cave.

Same as (CC-HC)1 except spray irrigation of effluent during dry season.

Option Identification: (CC-HC)3

Same as (CC-HC)1.

Same as (CC-HC)1 except discharge to Green River via force main conveyance.

Option Identification: (CC-HC)4

Abandon existing Cave City wastewater facilities for use as a raw wastewater pumping station; conveyance of Cave City wastewater to Horse Cave for joint treatment by force main and gravity interceptor.

Abandon existing Horse Cave wastewater treatment facilities; joint secondary (plus) treatment of Cave City and Horse Cave wastewaters by a 0.9 mgd oxidation ditch wastewater treatment facility (Class I reliability); gravity conveyance to Hidden River Cave discharge downstream of the east-south branch confluence.

Option Idenfication: (CC-HC)5

Same as (CC-HC)4.

Abandon existing Horse Cave wastewater treatment plant; joint secondary treatment of Cave City and Horse Cave wastewaters by a 0.9 mgd oxidation ditch wastewater treatment facility (Class III reliability); spray irrigation of treatment plant effluent during dry season and gravity conveyance to Hidden River Cave discharge during wet season.

Option Identification: (CC-HC)$^{6}$

Same as (CC-HC)$^{4}$.

↓

Same as (CC-HC)$^{5}$ except discharge to Green River via force main conveyance.

Option Identification: (CC-HC)$^{7}$

Secondary treatment of Cave City wastewaters (0.37 gmd) by upgraded existing Cave City wastewater treatment facility (Class III reliability, two-stage biological treatment); conveyance of Cave City effluent to Horse Cave by force main and gravity interceptor for joint disposal.

↓

Secondary treatment of Horse Cave wastewaters (0.53 mgd) by upgraded existing Horse Cave wastewater treatment facility (Class III reliability, two-stage biological treatment including preliminary treatment of Ken Dec wastewater (.25 mgd) by an aerated 24-hour equalization basin, first stage biological treatment of remaining 0.28 mgd by optimum use of existing treatment plant and secondary treatment by a 0.53 mgd activated sludge second stage biological treatment step); spray irrigation of combined Horse Cave-Cave City plant effluents during the dry season and discharge to Hidden River Cave by gravity conveyance during the wet season.

Option Identification: (CC-HC)$^{8*}$

Same as (CC-HC)$^{7}$.

↓

Same as (CC-HC)$^{7}$ except discharge of combined effluents to Green River via force main.

Joint Treatment Configuration: (PC-CC)

Population Centers: Park City
Cave City

Option Identification: (PC-CC)$^{1}$

Construction of Park City wastewater collection system; secondary treatment of Park City wastewater by a 0.08 mgd extended aeration wastewater treatment plant; conveyance of Park City treatment plant effluent to Cave City for joint disposal.

↓

Secondary treatment of Cave City wastewater (0.37 mgd) by upgraded existing Cave City wastewater treatment plant (Class III reliability); joint disposal of Cave City-Park City effluent by spray irrigation during the dry season and discharge to Hidden River Cave tributary during wet season.

Option Identification: (PC-CC)$^{2}$

Same as (PC-CC)$^{1}$.

↓

Secondary (plus) treatment of Cave City wastewater (0.37 mgd) by upgraded existing Cave City wastewater treatment plant (Class I reliability, two stage biological treatment); joint disposal of Cave City-Park City effluents by discharge to Hidden River Cave tributary.

Option Identification: (PC-CC)$^{3*}$

Same as (PC-CC)$^{1}$.

↓

Secondary (plus) treatment of Cave City wastewater by 0.37 mgd oxidation ditch wastewater treatment facility; joint disposal of Cave City-Park City effluents by discharge to Hidden River Cave tributary.

**Joint Treatment Configuration:** (SA-CC)

**Popualtion Centers:** Staging Area (including Rt. 70 development)
Cave City

Option Identification: (SA-CC)$^{1*}$

Gravity conveyance of wastewater from Staging Area to treatment plant site at Chaumont; gravity conveyance from Rt. 70 development west of Toohey Ridge to Staging Area wastewater treatment plant at Chaumont; secondary treatment of Staging Area and Rt. 70 wastewaters by a 0.105 mgd extended aeration plant at Chaumont; conveyance of Staging Area treatment plant effluent to Cave City via force main followed by gravity interceptor east of Toohey Ridge; (additional Rt. 70 development wastewater collected in gravity interceptor to Cave City).

↓

First stage biological treatment of Cave City wastewater (0.37 mgd) by the existing Cave City wastewater treatment facilities; joint secondary treatment of Cave City and treated-raw wastewater mixture from Staging Area by a 0.5 mgd activated sludge second stage biological treatment system; disposal of plant effluent by spray irrigation during the dry season and discharge to Hidden River Cave tributary during the wet season.

this is septic conditions developing in the force mains due to long detention times. Although facilities could be provided to maintain wastewater dissolved oxygen levels in the force mains, the expense of chemical addition or mechanical aeration does not appear to be justified when compared with the cost of providing secondary treatment of these relatively small volumes of wastewater prior to pumping as indicated in the 201 plan. In addition, there are potential environmental benefits associated with pumping treated rather than raw wastewater, since force main leaks or breaks would not present as serious a threat to subsurface cave systems. For these reasons, joint treatment/disposal options which involve pumping wastewater from either Park City or the Staging Area include treatment of these wastewaters by extended aeration prior to pumping for joint disposal.

The primary purpose for developing joint treatment/disposal options for the Mammoth Cave area is joint disposal rather than joint treatment since wastewater discharge sites in the study area are severely limited. Discharge of treated wastewater to the Green River is considered the only appropriate disposal method for combining wastewaters from three or more of the population centers. This appears to be the only practical method since year round spray irrigation would require large storage lagoons which are subject to collapse in karst areas and increasing discharge to Hidden River Cave from other population centers in addition to Cave City and Horse Cave appears to be environmentally unacceptable.

## PART E. WASTEWATER MANAGEMENT ALTERNATIVES EVALUATION

### 1. WASTEWATER MANAGEMENT ALTERNATIVES

There are eight wastewater management alternatives to be evaluated for the Mammoth Cave area. These are presented in Figures II-3 to II-10 and accompanying descriptions. The wastewater management alternatives correspond with the eight service configurations developed in Part B and include the specific wastewater collection, conveyance, treatment and disposal systems recommended in Part C.

The basis for the evaluation of these eight wastewater management alternatives is the cost-effectiveness analysis. The cost-effectiveness analysis provides a method for gauging the overall "resource costs" of a particular alternative since it accounts for factors in addition to monetary costs. Although consideration of monetary costs is a major factor in cost-effectiveness analysis, it is only one of four criteria used in the analysis. These four criteria are net present worth costs, impacts on the natural and man-made environment, system operability, and implementability.

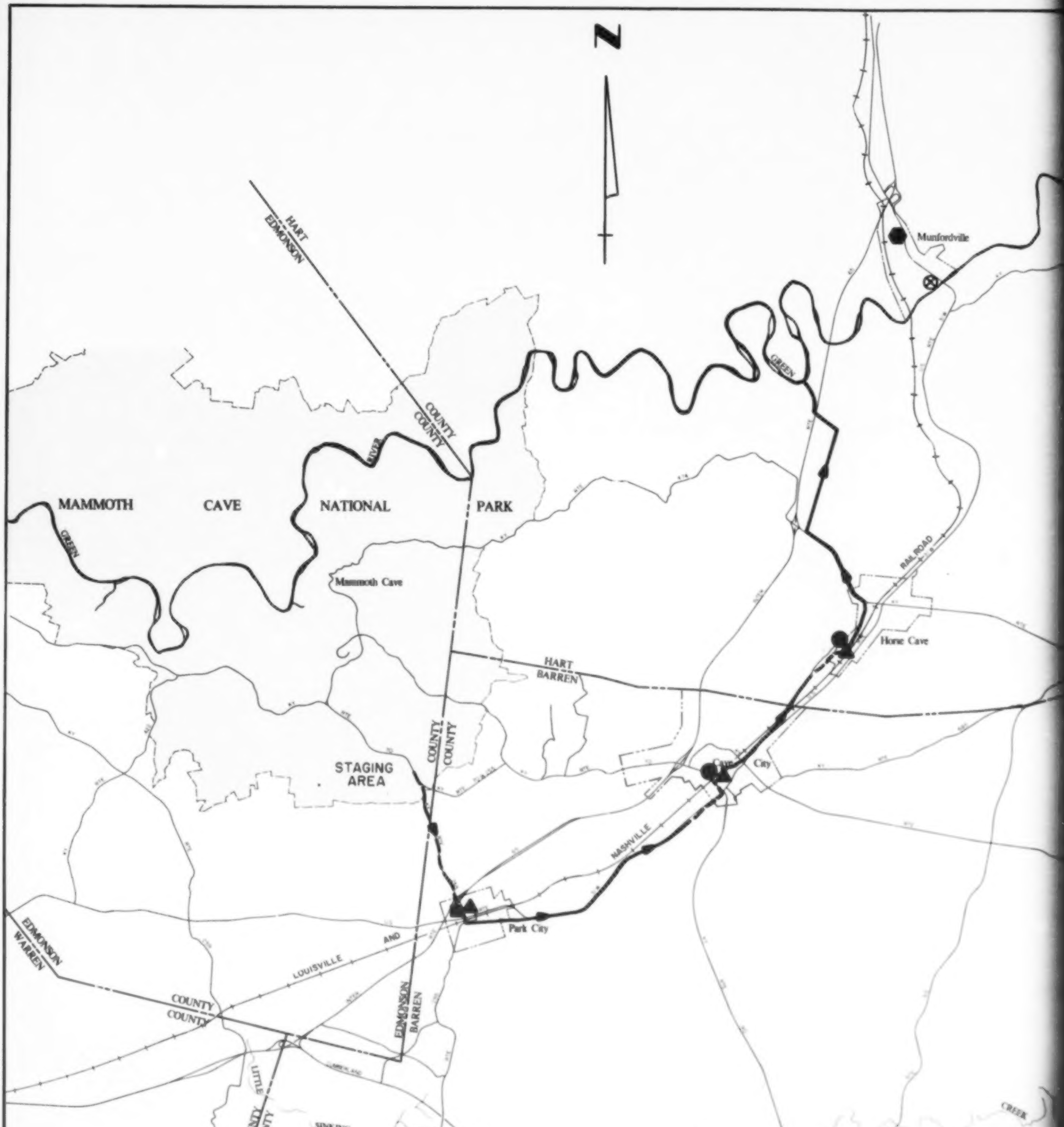
Net present worth cost is the total project cost associated with a wastewater management alternative plus the present worth of annual operation and maintenance costs during the planning period, minus the present worth of the salvage value of the treatment/disposal systems at the end of the planning period (year 2000). Impacts on the natural environment include impacts on the aquatic (both surface and subsurface) and terrestrial environment and eco-systems, while impacts on the man-made environment comprise impacts on transportation, public water systems, etc. as well as socio-economic impacts. System operability provides a measure of the ability of a wastewater treatment/disposal system to continuously provide the service for which it is designed and includes such factors as system flexibility, reliability and maintainability. Finally, implementability evaluation provides a method to assess the factors that may affect the implementation of a particular wastewater management plan. This includes political considerations as well as local financial capabilities. It is in this evaluation that local annual costs are examined.

## WASTEWATER MANAGEMENT ALTERNATIVE 6

(SA-PC-CC-HC) 2 plus MN-1

Major Components:

- Gravity sewer from proposed Staging Area to Park City treatment plant
- Wastewater collection system at Park City
- Extended aeration treatment facility (0.16 mgd) at Park City
- Conveyance facilities to transport treated wastewater from Park City to Cave City
- Upgraded (.37 mgd) existing Cave City treatment facility (Secondary treatment, Class III reliability)
- Pump station and force main to convey commonly treated wastewater to the Green River discharge point
- Additional on-lot treatment systems at Munfordville
- Conveyance facilities to transport treated wastewater from Cave City to Horse Cave.
- Upgraded (0.53 mgd) existing Horse Cave treatment facility (Secondary treatment, Class II reliability)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Horse Cave
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BARREN
STAGING
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City
NASHVILLE
Park City
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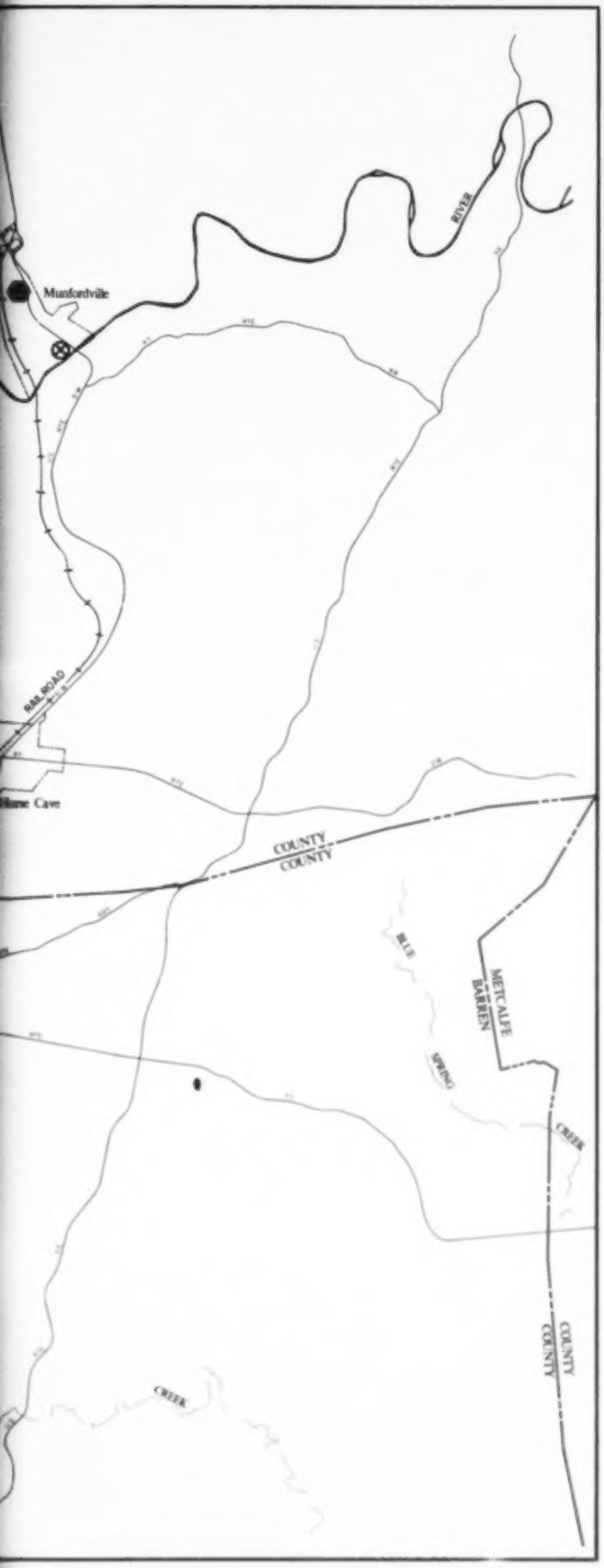
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## LEGEND

| | |
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| ▭ | MAMMOTH CAVE NATIONAL PARK |
| ——— | FORCE MAIN |
| - - - - | GRAVITY INTERCEPTOR |
| ⊗ | EXISTING TREATMENT FACILITY |
| ● | UPGRADED EXISTING FACILITY |
| ■ | NEW WASTEWATER TREATMENT FACILITY |
| ▲ | PUMPING STATION |
| ⬣ | ON-LOT SYSTEMS |

FIGURE II-3

MAMMOTH CAVE AREA
201 FACILITIES PLAN

ENVIRONMENTAL IMPACT STATEMENT

## WASTEWATER MANAGEMENT ALTERNATIVE I

(SA-PC-CC-HC)2 PLUS MN-I

12,000 6000 0 12,000 24,000
Scale In Feet

U.S. Environmental Protection Agency
Region IV Atlanta, Georgia

# WASTEWATER MANAGEMENT ALTERNATIVE 2

(PC-SA-CC-HC) 2 plus MN-1

**Major Components:**

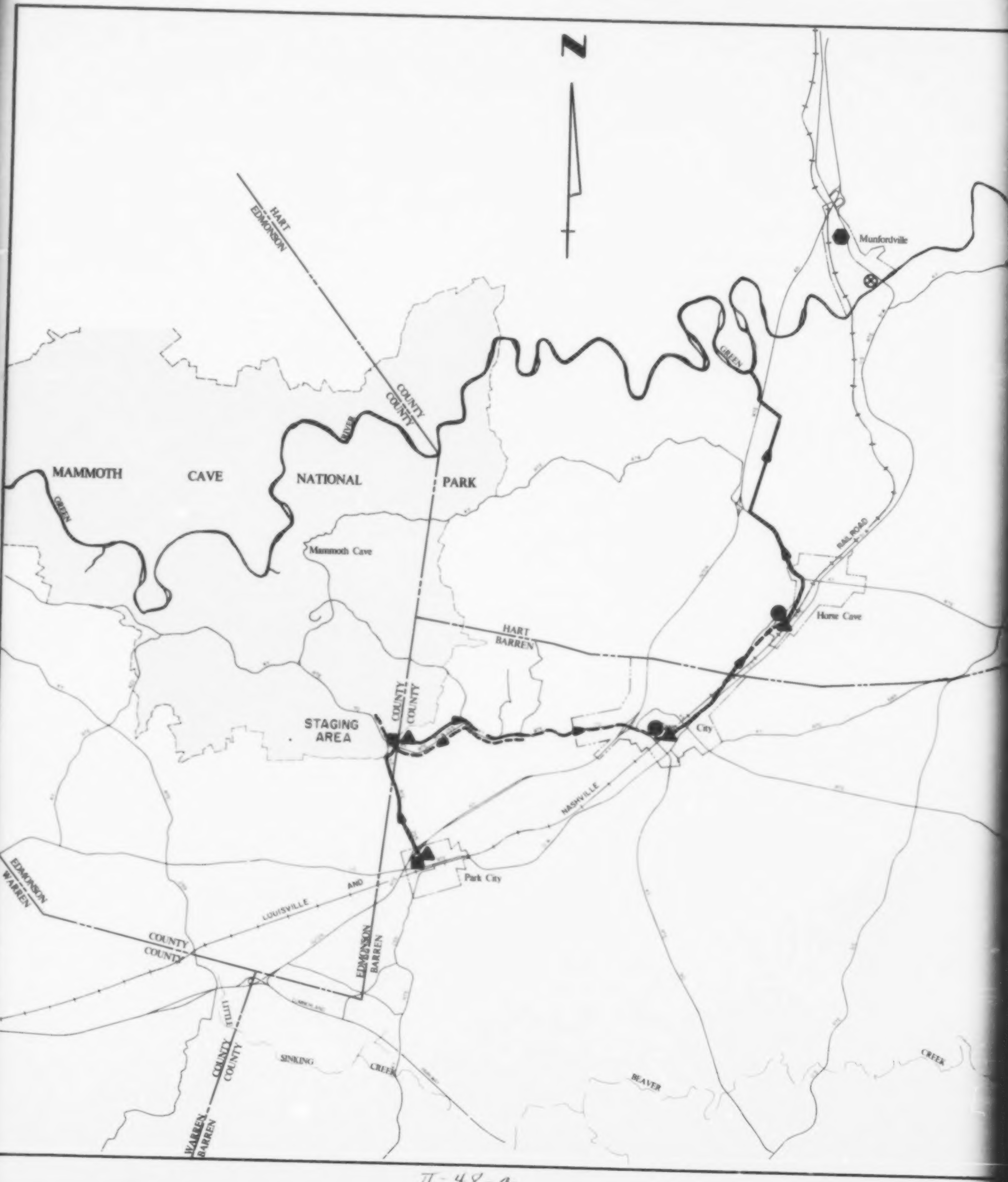
- Wastewater collection system at Park City
- Extended aeration facility (.08 mgd) at Park City
- Pump station and force main to convey treated wastewater from Park City to Chaumont treatment site pump station
- Gravity line to convey raw wastewater from the proposed Staging Area to the Chaumont treatment plant site
- Gravity interceptor to convey raw wastewater from Rt. 70 development to the Chaumont wastewater treatment facility
- Extended aeration wastewater treatment facility (0.105 mgd) at Chaumont for Staging Area and Rt. 70 wastewater
- Pump station at force main at Chaumont to convey combined treated wastewaters to gravity interceptor for gravity flow to Cave City along Rt. 70
- Gravity interceptor to convey treated wastewater and additional raw wastewater to Cave City
- Upgraded (.58 mgd) existing Cave City treatment facility (Secondary Treatment Class III reliability)
- Conveyance facilities to transport treated wastewaters to Horse Cave pumping station
- Upgraded (.53 mgd) existing Horse Cave facility (Secondary treatment, Class III reliability)
- Pump station at force main to convey treated wastewaters to the Green River discharge point
- Additional on-lot treatment systems at Munfordville

## WASTEWATER MANAGEMENT ALTERNATIVE 3

SA plus (PC-CC-HC) 3 plus MN-1

**Major Components:**

- Composting waterless toilets - septic tank/soil absorption system for greywater at the proposed Staging Area
- Wastewater collection system at Park City
- Extended aeration wastewater treatment facility (0.08 mgd) at Park City
- Conveyance facilities to transport treated wastewater from Park City to Cave City
- Upgraded (.45 mgd) existing Cave City treatment plant (Secondary treated, Class III reliability)
- Pump station and force main to convey treated wastewater to Green River discharge point
- Additional on-lot systems at Munfordville



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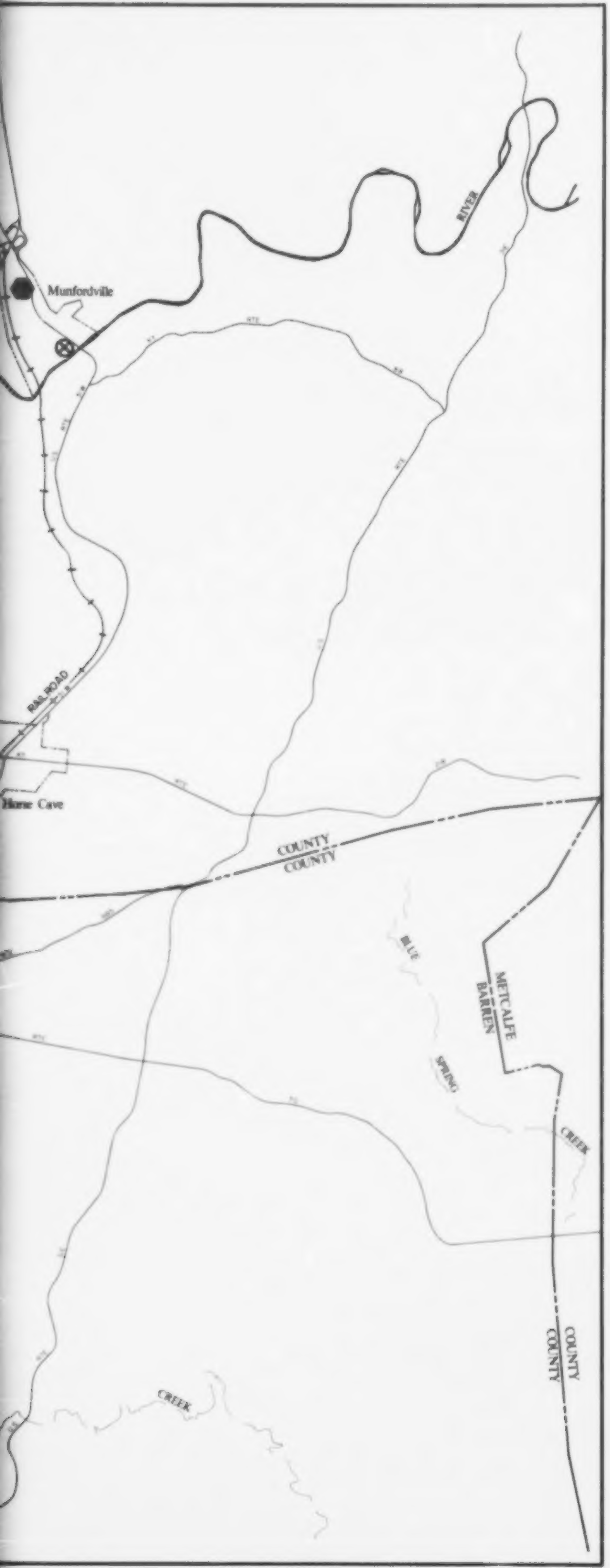
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## LEGEND

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| ▭ | MAMMOTH CAVE NATIONAL PARK |
| ——— | FORCE MAIN |
| – – – – | GRAVITY INTERCEPTOR |
| ⊗ | EXISTING TREATMENT FACILITY |
| ● | UPGRADED EXISTING FACILITY |
| ■ | NEW WASTEWATER TREATMENT FACILITY |
| ▲ | PUMPING STATION |
| ⬣ | ON-LOT SYSTEMS |

FIGURE II-4

MAMMOTH CAVE AREA
201 FACILITIES PLAN

ENVIRONMENTAL IMPACT STATEMENT

## WASTEWATER MANAGEMENT ALTERNATIVE 2

(PC-SA-CC-HC)2 PLUS MN-1

12,000 6000 0 12,000 24,000
Scale In Feet

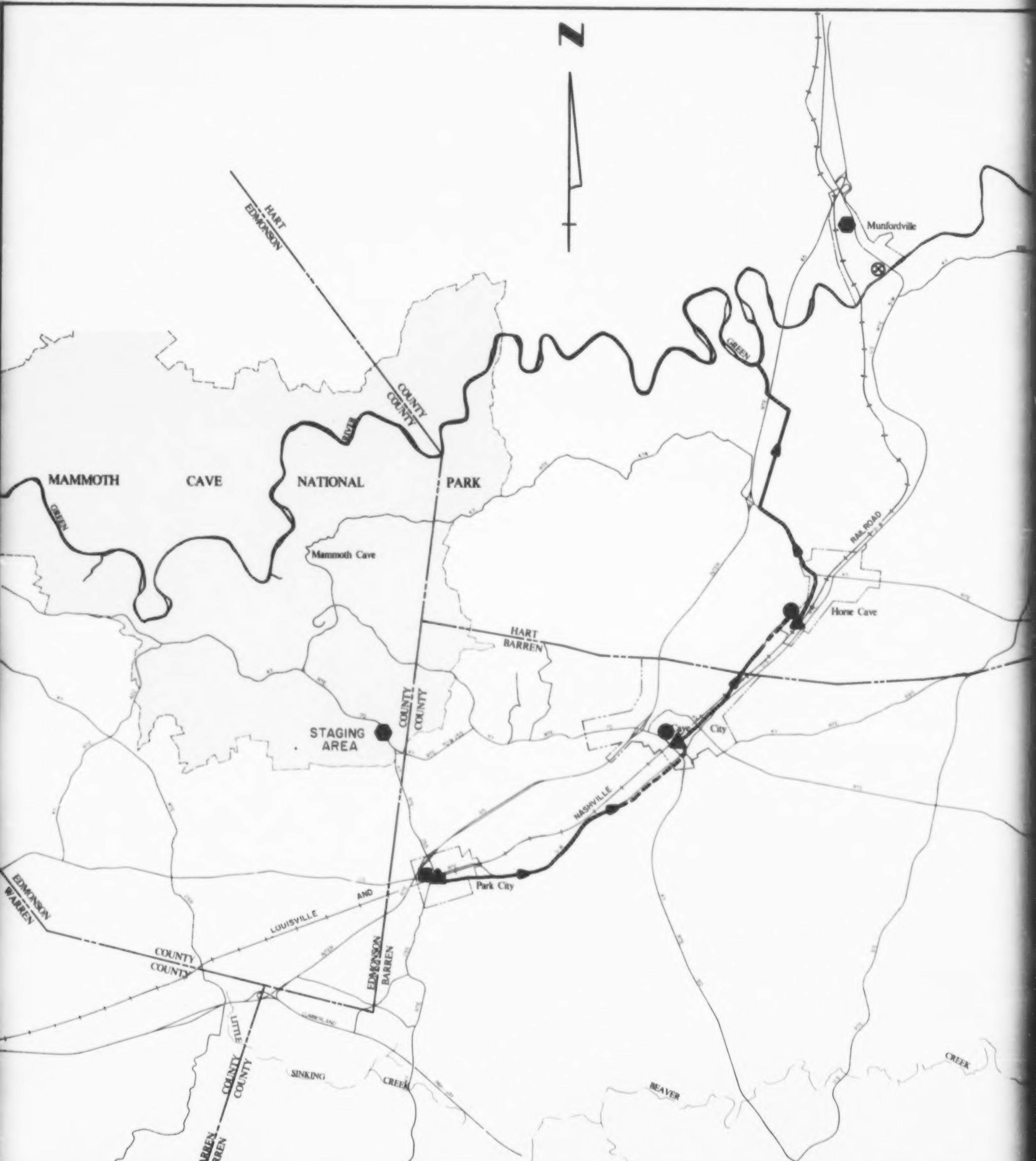
U.S. Environmental Protection Agency
Region IV Atlanta, Georgia

## WASTEWATER MANAGEMENT ALTERNATIVE 4

PC-2 plus (SA-CC-HC) 3 plus MN-1

**Major Components:**

- Conventional and alternate on-lot treatment systems at Park City
- Small community low pressure sewer system and community soil absorption field at Park City
- Gravity conveyance to transport raw wastewater from proposed Staging Area to Chaumont treatment site
- Gravity interceptor to convey wastewater from Rt. 70 development to the treatment facility at Chaumont
- Extended aeration wastewater treatment facility (0.105 mgd) at Chaumont for Staging Area and Rt. 70 wastewater
- Pump station at force main at Chaumont to convey treated wastewater to gravity interceptor for gravity flow to Cave City along Rt. 70
- Gravity interceptor to convey treated wastewater and additional raw wastewater to Cave City treatment facility
- Upgraded (.5 mgd) existing Cave City treatment plant (Secondary treatment, Class III reliability)
- Gravity and facilities to transport treated wastewater from Cave City to Horse Cave
- Upgraded (.53 mgd) existing Horse Cave treatment facilities (Secondary treatment Class III reliability)
- Pump station and force main to convey treated wastewater to discharge
- Additional on-lot treatment systems at Munfordville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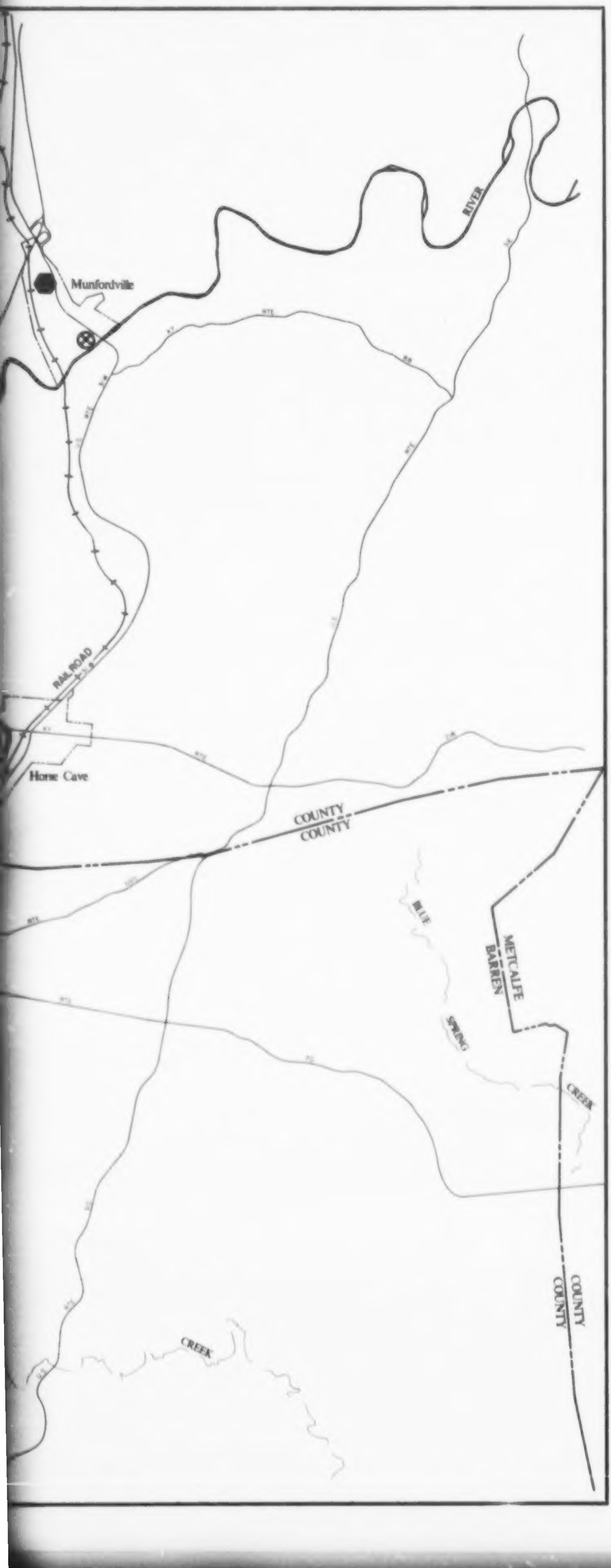
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## LEGEND

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| ▭ | MAMMOTH CAVE NATIONAL PARK |
| —— | FORCE MAIN |
| ---- | GRAVITY INTERCEPTOR |
| ⊗ | EXISTING TREATMENT FACILITY |
| ● | UPGRADED EXISTING FACILITY |
| ■ | NEW WASTEWATER TREATMENT FACILITY |
| ▲ | PUMPING STATION |
| ⬢ | ON-LOT SYSTEMS |

FIGURE II-5

MAMMOTH CAVE AREA
201 FACILITIES PLAN

ENVIRONMENTAL IMPACT STATEMENT

# WASTEWATER MANAGEMENT ALTERNATIVE 3

## SA PLUS (PC-CC-HC)3 PLUS MN-1

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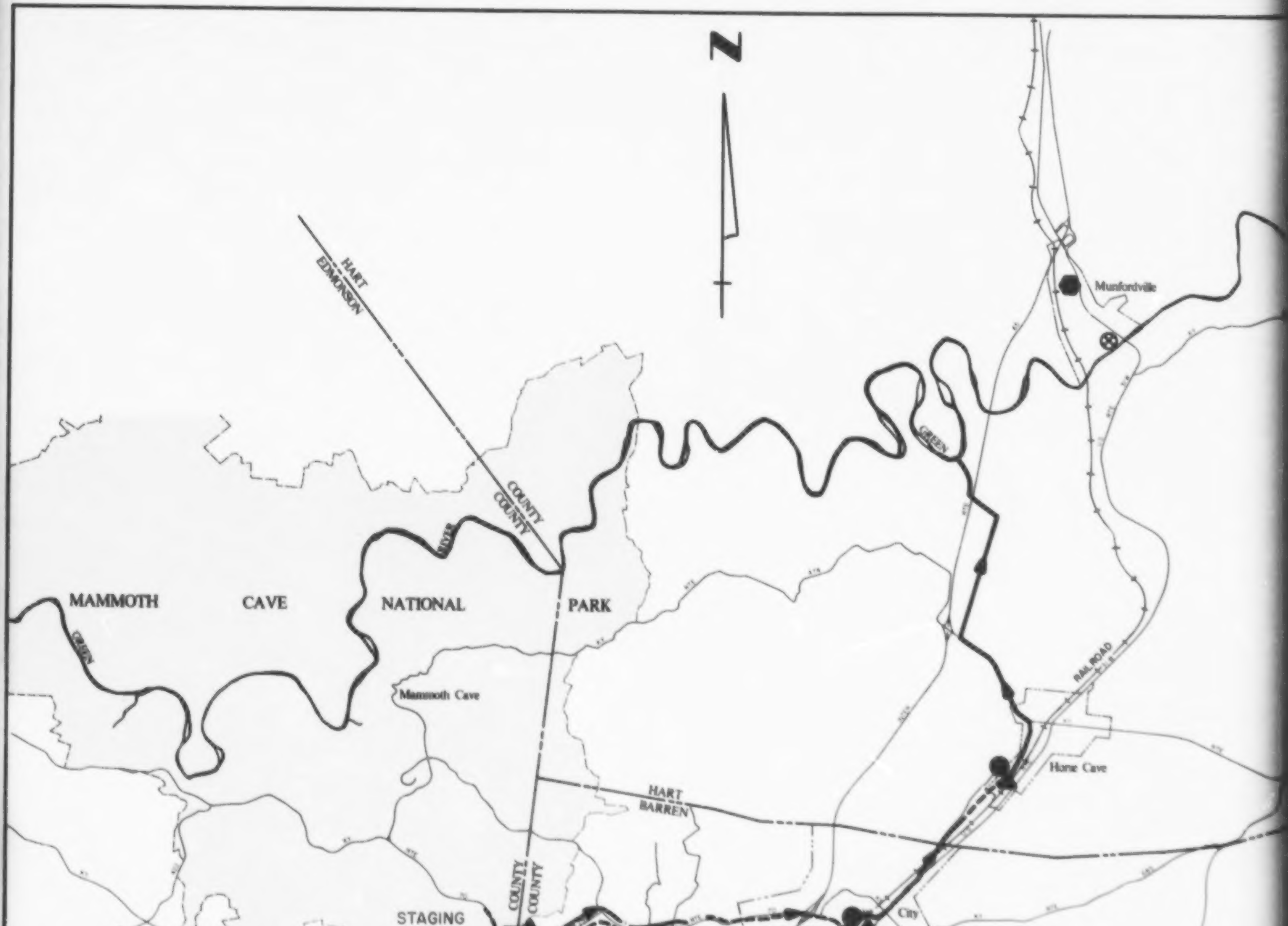
Scale In Feet

U.S. Environmental Protection Agency
Region IV Atlanta, Georgia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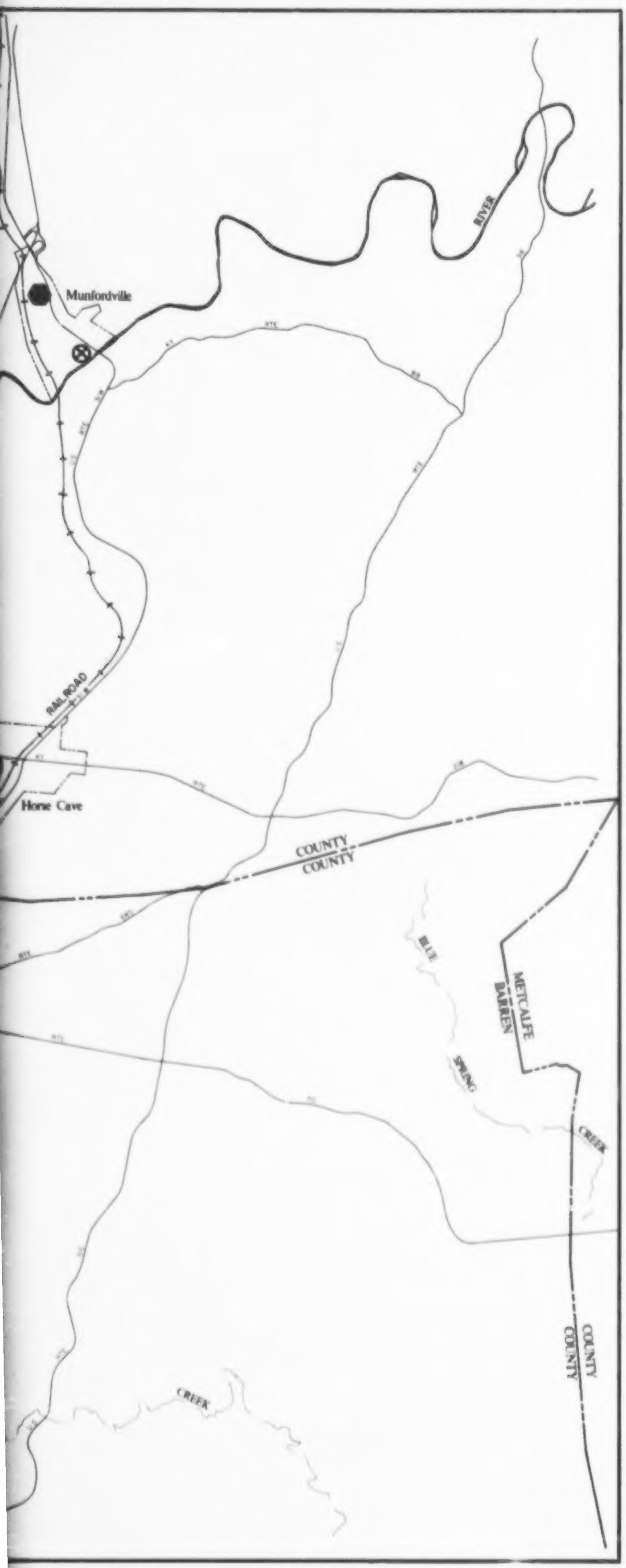
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## LEGEND

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| ▭ | MAMMOTH CAVE NATIONAL PARK |
| ── | FORCE MAIN |
| ---- | GRAVITY INTERCEPTOR |
| ⊗ | EXISTING TREATMENT FACILITY |
| ● | UPGRADED EXISTING FACILITY |
| ■ | NEW WASTEWATER TREATMENT FACILITY |
| ▲ | PUMPING STATION |
| ⬢ | ON-LOT SYSTEMS |
| ▨ | LAND APPLICATION SITE |

FIGURE II-6

MAMMOTH CAVE AREA
201 FACILITIES PLAN

ENVIRONMENTAL IMPACT STATEMENT
**WASTEWATER MANAGEMENT**
**ALTERNATIVE 4**
PC - 2 PLUS (SA - CC - HC) 3 PLUS MN - 1

12,000 6000 0 12,000 24,000
Scale In Feet

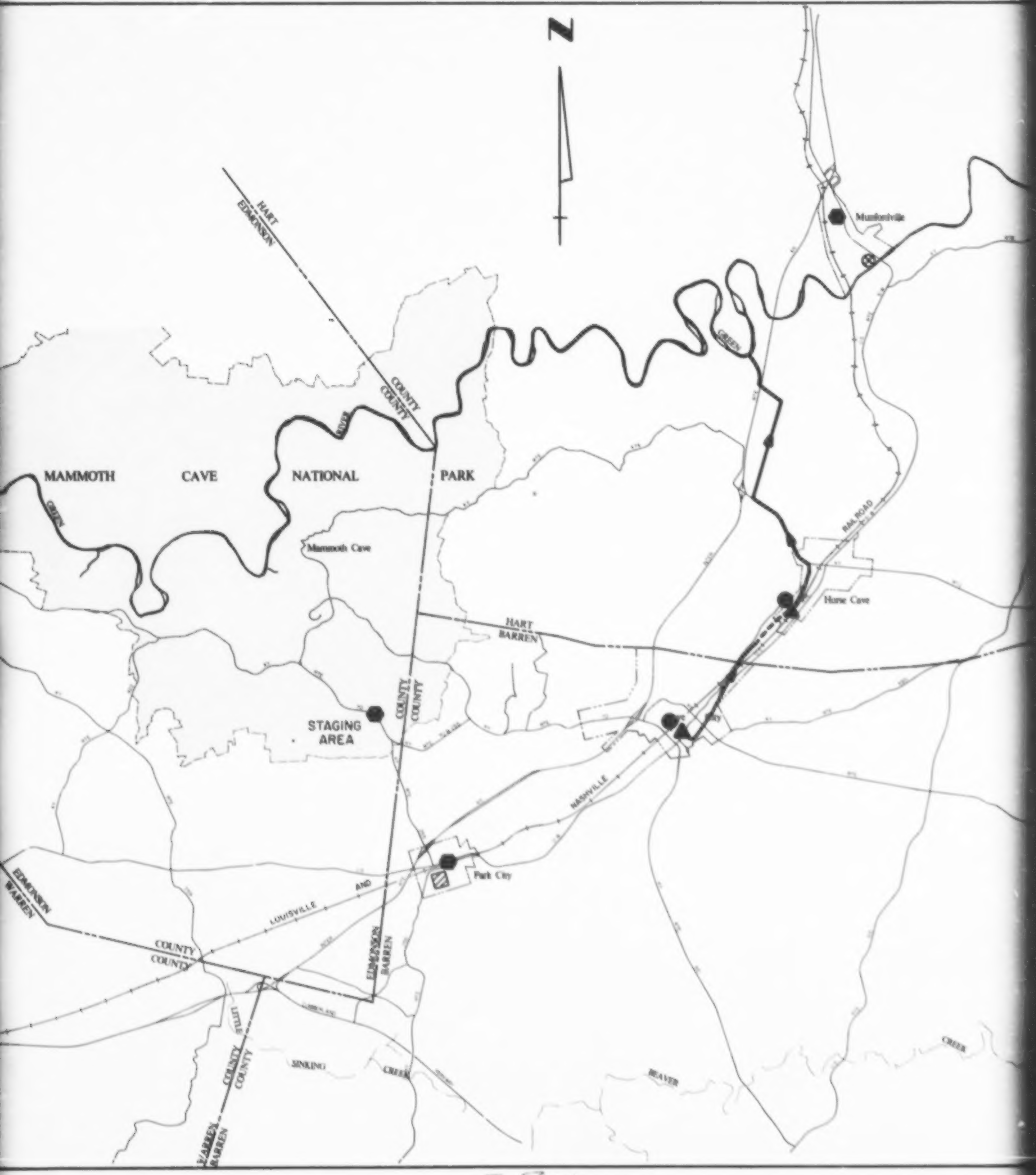
U.S. Environmental Protection Agency
Region IV Atlanta, Georgia

# WASTEWATER MANAGEMENT ALTERNATIVE 5

SA plus PC-2 plus (CC-HC) 8 plus MN-1

**Major Components:**

- Composting waterless toilets - septic tank/soil absorption system for greywater at the proposed Staging Area
- Conventional and alternate on-lot treatment systems at Park City
- Small community low pressure sewer system and community soil absorption field at Park City
- Upgraded (.37 mgd) existing Cave City treatment plant (Secondary treatment Class III reliability)
- Conveyance facilities to transport treated wastewater from Cave City plant to Horse Cave
- Upgraded (.53 mgd) existing Horse Cave treatment plant (Secondary treatment Class III reliability)
- Pump station and force main to convey treated wastewater to Green River discharge point
- Additional on-lot treatment systems at Munfordville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RAILROAD
STAGING AREA
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NASHVILLE
Park City
EDMONSON
BARREN
LOUISVILLE
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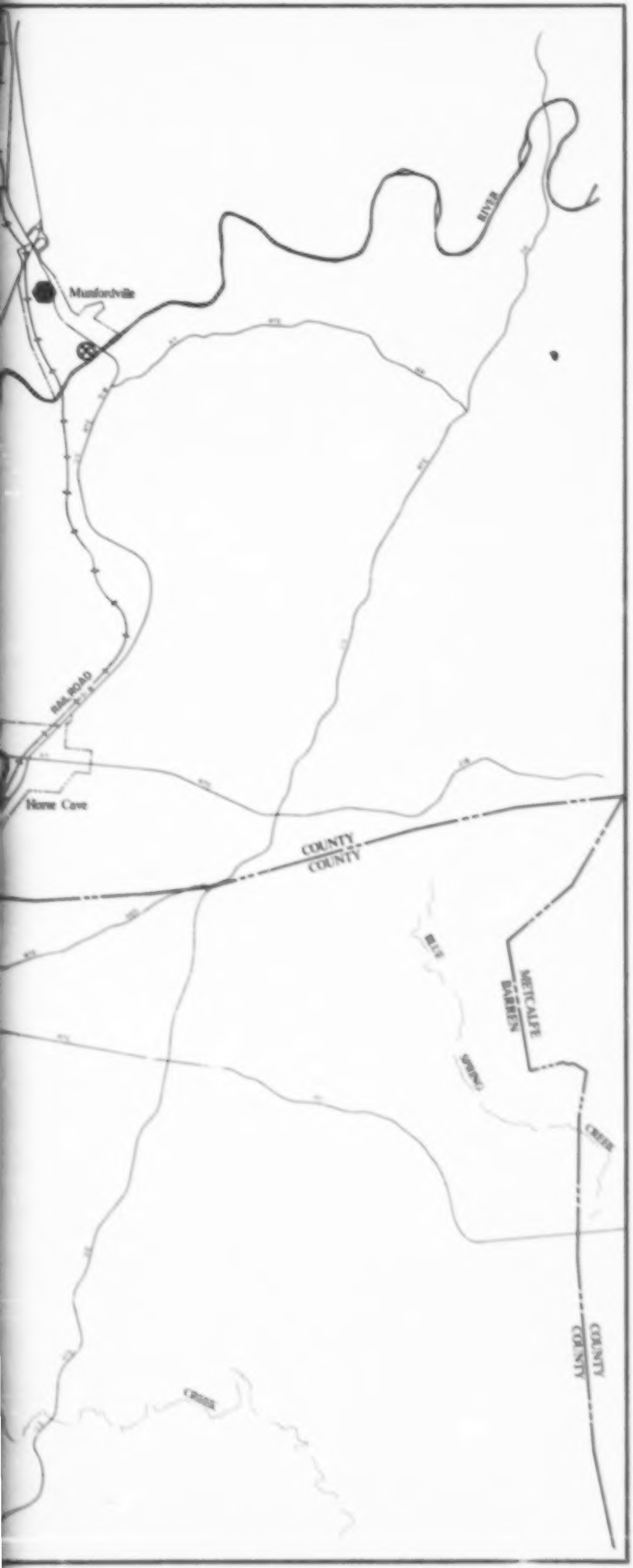
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CREEK

## LEGEND

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| ▭ | MAMMOTH CAVE NATIONAL PARK |
| ── | FORCE MAIN |
| ---- | GRAVITY INTERCEPTOR |
| ⊗ | EXISTING TREATMENT FACILITY |
| ● | UPGRADED EXISTING FACILITY |
| ▲ | PUMPING STATION |
| ⬢ | ON-LOT SYSTEMS |
| ▨ | LAND APPLICATION SITE |

FIGURE II-7

MAMMOTH CAVE AREA
201 FACILITIES PLAN

ENVIRONMENTAL IMPACT STATEMENT

## WASTEWATER MANAGEMENT
## ALTERNATIVE 5

SA PLUS PC-2 PLUS (CC-HC)8 PLUS MN-1

12,000 6000 0 12,000 24,000
Scale In Feet

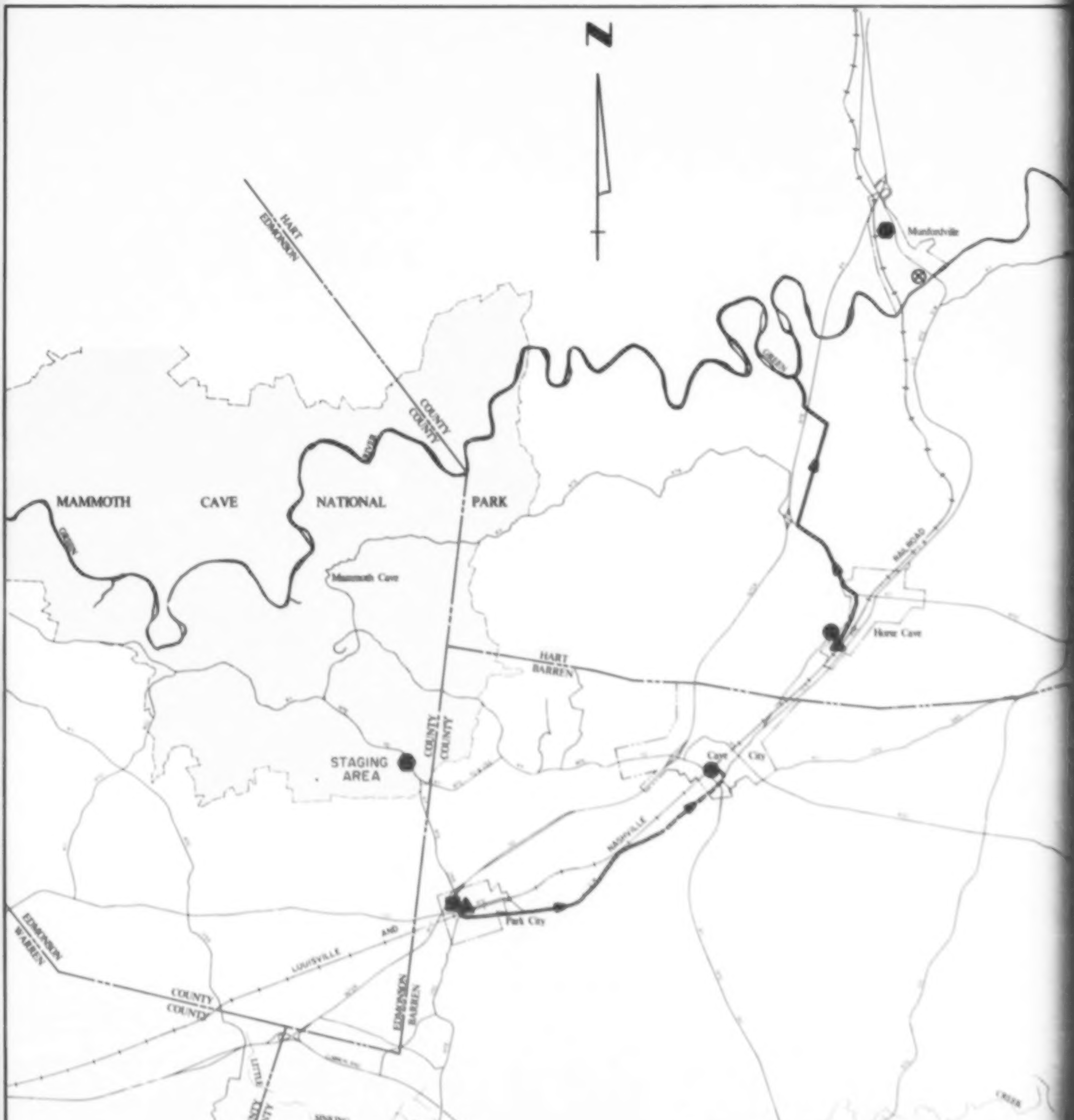
U.S. Environmental Protection Agency
Region IV Atlanta, Georgia

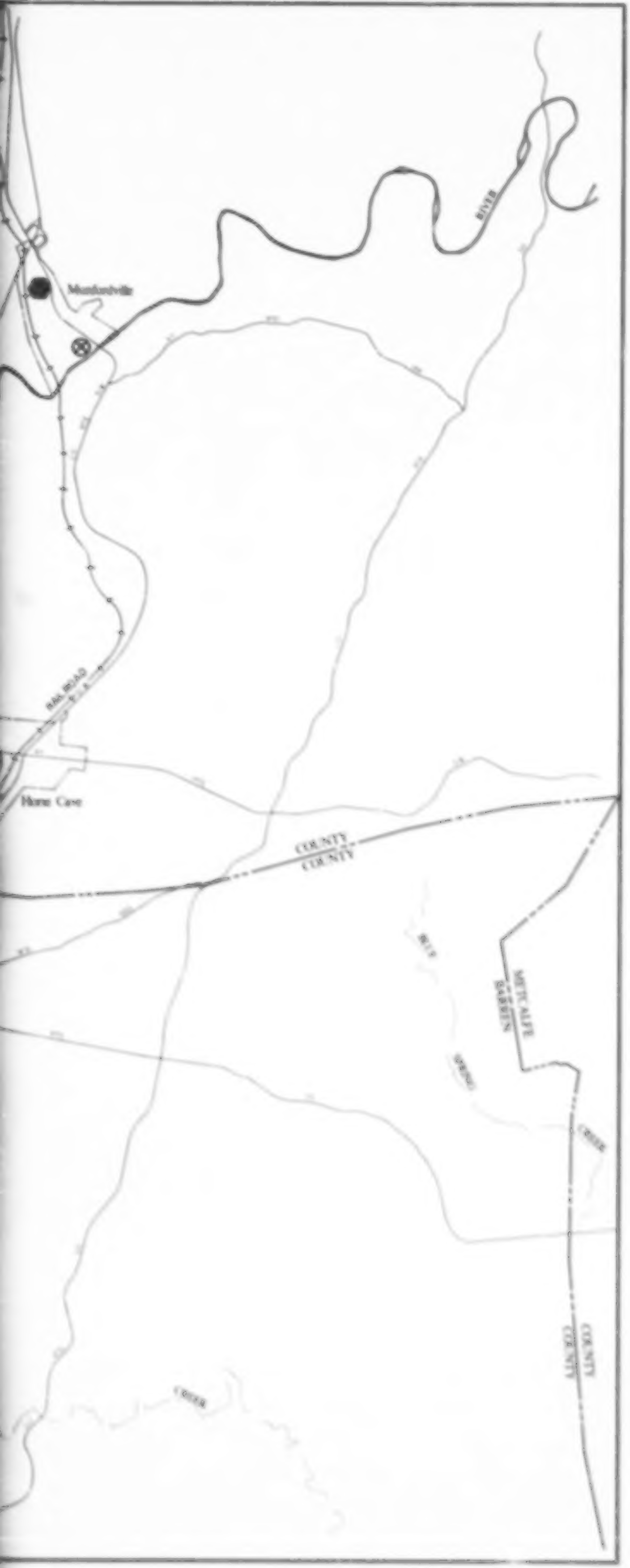
# WASTEWATER MANAGEMENT ALTERNATIVE 6

SA plus (PC-CC) 2 plus HC-4 plus MN-1

**Major Components:**

- Composting waterless toilets - septic tank soil absorption system for greywater at the proposed Staging Area
- Wastewater collection system at Park City
- Extended aeration wastewater treatment facility (0.08 mgd) at Park City
- Conveyance facilities to transport treated wastewater to Cave City discharge point
- Upgraded (.37 mgd) existing wastewater treatment plant at Cave City (Advanced-secondary, Class I reliability)
- Subsurface discharge at Cave City
- Upgraded (.53 mgd) existing Horse Cave wastewater treatment facility (Secondary treatment, Class III reliability)
- Pumping station and force main to convey treated Horse Cave wastewater to the Green River discharge point
- Additional on-lot treatment systems at Munfordville


N
HART COUNTY
EDMONSON COUNTY
MAMMOTH CAVE NATIONAL PARK
GREEN RIVER
GREEN
Munfordville
Mammoth Cave
Horse Cave
RAILROAD
HART BARREN
STAGING AREA
COUNTY COUNTY
Cave City
NASHVILLE
Park City
LOUISVILLE AND
EDMONSON WARREN
COUNTY COUNTY
EDMONSON BARREN
LITTLE
WARREN BARREN
COUNTY COUNTY
SINKING CREEK
BEAVER
CREEK


RIVER
Munfordville
RAILROAD
Horse Cave
COUNTY
COUNTY
BLUE
METCALFE
BARREN
SPRING
CREEK
COUNTY
COUNTY
CREEK

## LEGEND

| | |
|---|---|
| ▭ | MAMMOTH CAVE NATIONAL PARK |
| ——— | FORCE MAIN |
| ---- | GRAVITY INTERCEPTOR |
| ⊗ | EXISTING TREATMENT FACILITY |
| ● | UPGRADED EXISTING FACILITY |
| ■ | NEW WASTEWATER TREATMENT FACILITY |
| ▲ | PUMPING STATION |
| ⬣ | ON-LOT SYSTEMS |

FIGURE II-8

MAMMOTH CAVE AREA
201 FACILITIES PLAN

ENVIRONMENTAL IMPACT STATEMENT

## WASTEWATER MANAGEMENT
## ALTERNATIVE 6

SA PLUS (PC-CC) 2 PLUS HC-4 PLUS MN-1

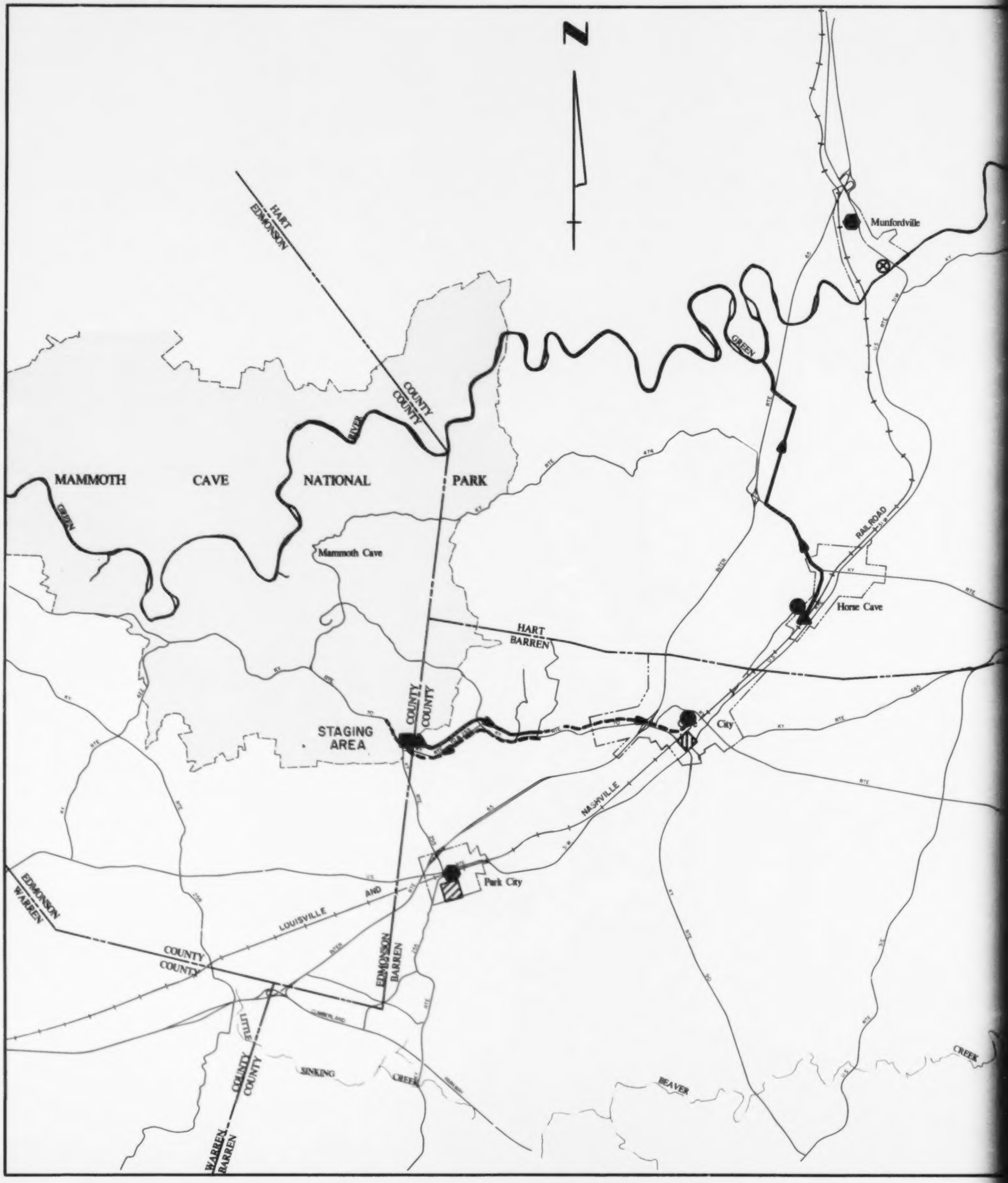
12,000 6000 0 12,000 24,000
Scale in Feet

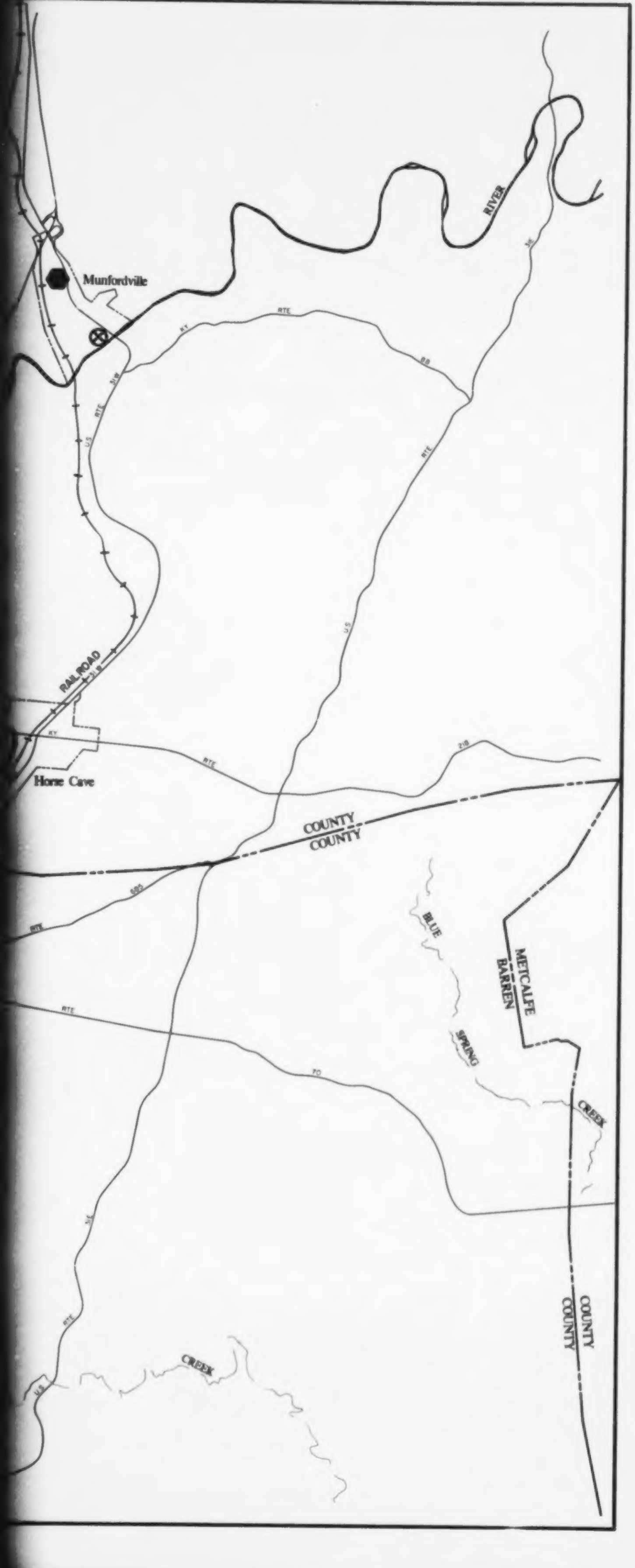
U.S. Environmental Protection Agency
Region IV Atlanta, Georgia

## WASTEWATER MANAGEMENT ALTERNATIVE 7
### PC-2 plus (SA-CC) plus HC-4 plus MN-1

**Major Components:**

- Conventional and alternate on-lot systems at Park City
- Small community low pressure sewer system and community soil absorption field at Park City
- Gravity conveyance to transport raw wastewater from proposed Staging Area to Chaumont treatment site
- Gravity interceptor to convey wastewater from Rt. 70 development to the treatment facility at Chaumont
- Extended aeration wastewater treatment facility (0.105 mgd) at Chaumont from Staging Area and Rt. 70 wastewater
- Pump station and force main at Chaumont to convey treated wastewater to gravity interceptor for gravity flow to Cave City along Rt. 70
- Gravity interceptor to convey treated wastewater and additional raw wastewater to Cave City treatment facility
- Upgraded existing (0.45 mgd) Cave City wastewater treatment plant (Secondary treatment, Class III reliability)
- Spray irrigation land application system (Dry season operation)
- Subsurface discharge (wet season operation)
- Upgraded (.53 mgd) existing Horse Cave treatment wastewater treatment facility (Secondary treatment, Class III reliability)
- Pumping station and force main to convey treated Horse Cave wastewater to the Green River discharge point
- Additional on-lot treatment systems at Munfordville


N
MAMMOTH CAVE NATIONAL PARK
Mammoth Cave
GREEN RIVER
GREEN
HART COUNTY
EDMONSON COUNTY
Munfordville
Horse Cave
HART
BARREN
STAGING AREA
City
Park City
RAILROAD
NASHVILLE
LOUISVILLE AND
EDMONSON
WARREN
COUNTY
COUNTY
EDMONSON
BARREN
WARREN
BARREN
LITTLE
SINKING CREEK
BEAVER
CREEK
KY RTE
US RTE
INTER
474
685
70
255
65
31W


Munfordville
RIVER
KY
RTE
88
31E
U.S.
31W
RTE
RAILROAD
KY
RTE
218
Horse Cave
COUNTY
COUNTY
335
RTE
BLUE
METCALFE
BARREN
RTE
70
SPRING
CREEK
31E
COUNTY
COUNTY
RTE
CREEK
U.S.

## LEGEND

| | |
|---|---|
| ▭ | MAMMOTH CAVE NATIONAL PARK |
| ― | FORCE MAIN |
| ---- | GRAVITY INTERCEPTOR |
| ⊗ | EXISTING TREATMENT FACILITY |
| ● | UPGRADED EXISTING FACILITY |
| ■ | NEW WASTEWATER TREATMENT FACILITY |
| ▲ | PUMPING STATION |
| ⬢ | ON-LOT SYSTEMS |
| ▨ | LAND APPLICATION SITE |

FIGURE II-9

MAMMOTH CAVE AREA
201 FACILITIES PLAN

ENVIRONMENTAL IMPACT STATEMENT

## WASTEWATER MANAGEMENT ALTERNATIVE 7

PC-2 PLUS (SA-CC) PLUS HC-4 PLUS MN-1

12,000 6000 0 12,000 24,000
Scale In Feet

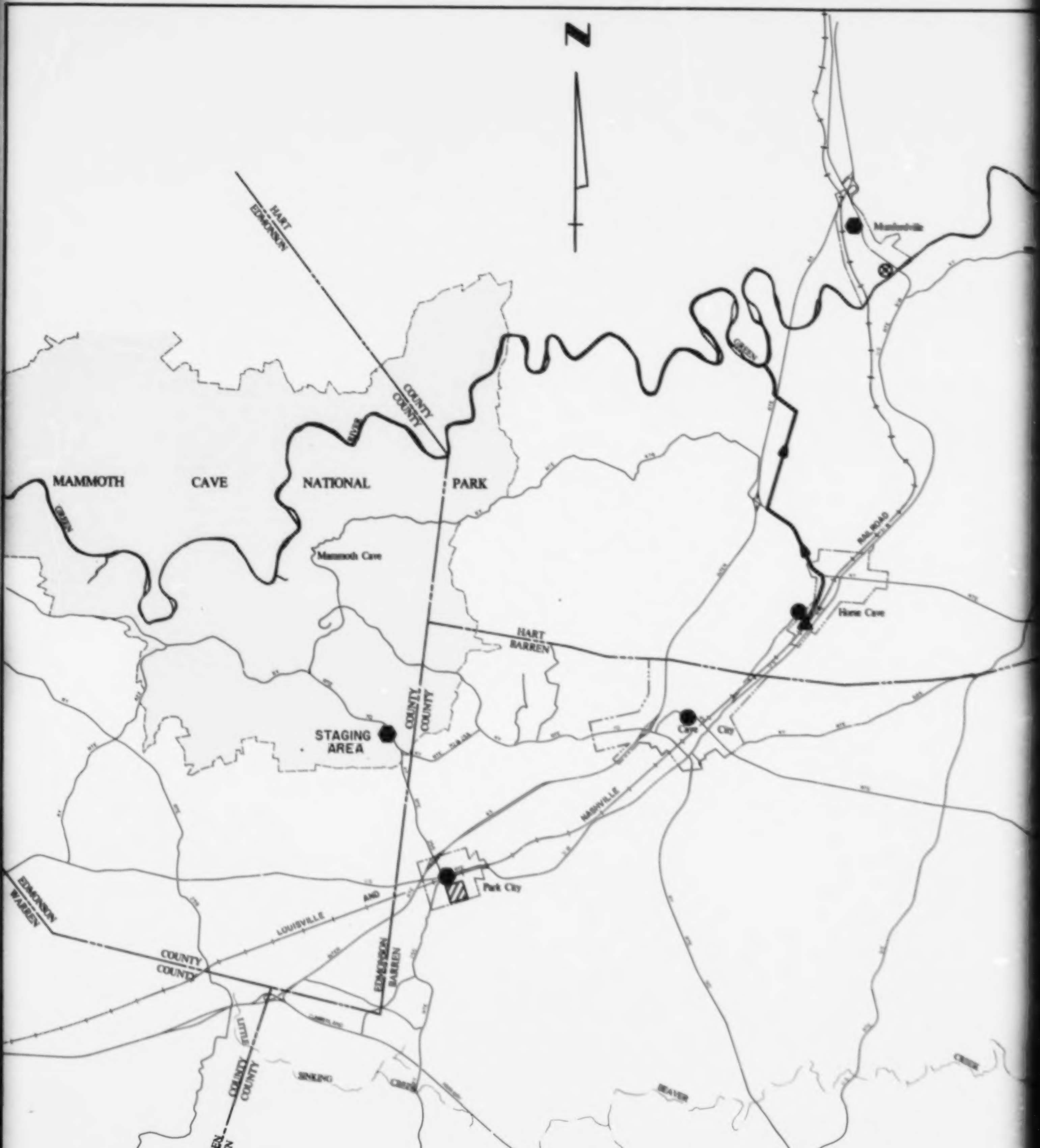
U.S. Environmental Protection Agency
Region IV Atlanta, Georgia

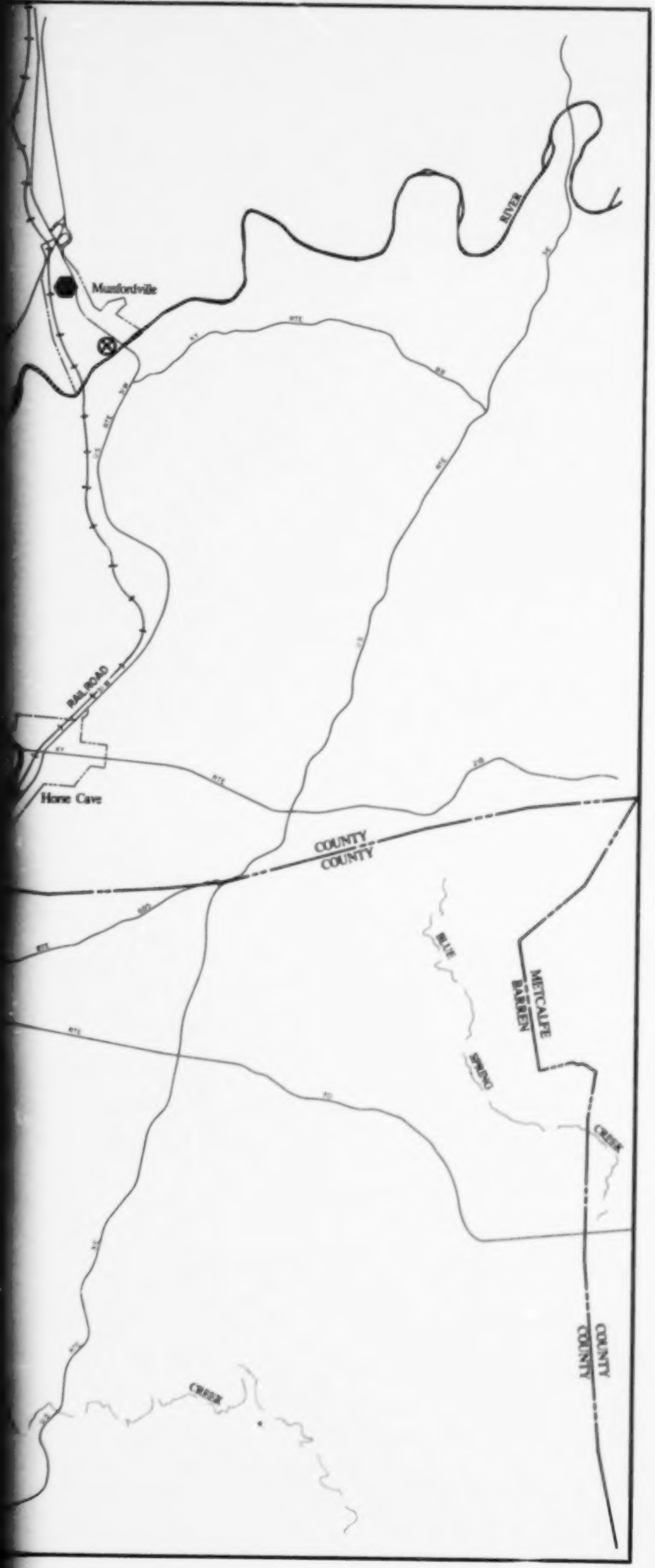
## WASTEWATER MANAGEMENT ALTERNATIVE 8

### PC-2 plus SA plus CC-3 plus HC-4 plus MN-1

Major Components:

- Conventional and alternate on-lot systems at Park City
- Small community low pressure sewer system and community soil absorption field at Park City
- Composting water less toilets - septic tank/soil absorption system for greywater at the proposed Staging Area
- Upgraded (.37 mgd) existing wastewater treatment plant at Cave City (Advanced-secondary, Class I reliability)
- Subsurface discharge of Cave City effluent
- Upgraded (.53 mgd) existing Horse Cave wastewater treatment facility (Secondary treatment, Class III reliability)
- Pumping station and force main to convey treated Horse Cave wastewater to the Green River discharge point
- Additional on-lot treatment systems at Munfordville


N
HART
EDMONSON
COUNTY
COUNTY
MAMMOTH
CAVE
NATIONAL
PARK
GREEN
RIVER
GREEN
Mammoth Cave
Munfordville
GREEN
RAILROAD
Horse Cave
HART
BARREN
COUNTY
COUNTY
STAGING
AREA
Cave
City
NASHVILLE
Park City
EDMONSON
WARREN
LOUISVILLE
AND
COUNTY
COUNTY
EDMONSON
BARREN
LITTLE
COUNTY
COUNTY
SINKING
CREEK
BEAVER
CREEK
WARREN
BARREN


RIVER
Munfordville
RAILROAD
Horse Cave
COUNTY
COUNTY
BLUE
SPRING
METCALFE
BARREN
CREEK
COUNTY
COUNTY
CREEK

## LEGEND

| | |
|---|---|
| ▭ | MAMMOTH CAVE NATIONAL PARK |
| —— | FORCE MAIN |
| ---- | GRAVITY INTERCEPTOR |
| ⊗ | EXISTING TREATMENT FACILITY |
| ● | UPGRADED EXISTING FACILITY |
| ▲ | PUMPING STATION |
| ⬣ | ON-LOT SYSTEMS |
| ▨ | LAND APPLICATION SITE |

FIGURE II-10

MAMMOTH CAVE AREA
201 FACILITIES PLAN

ENVIRONMENTAL IMPACT STATEMENT

**WASTEWATER MANAGEMENT**
**ALTERNATIVE 8**
**PC-2 PLUS SA PLUS CC-3**
**PLUS HC-4 PLUS MN-1**

12,000 6000 0 12,000 24,000
Scale In Feet

U.S. Environmental Protection Agency
Region IV Atlanta, Georgia

## 2. COST EVALUATION

A detailed evaluation of all significant cost components of the alternative wastewater management systems is required in order to perform the comparative cost analyses. Construction, project, and operation and maintenance costs are developed for each management system for incorporation into a net present worth cost analysis. The present worth cost analysis establishes a basis for comparison of total costs (capital and annual operations costs) for each of the wastewater management alternatives. These total costs include the federal share of the costs associated with construction grants. Comparative cost analysis (either present worth or equivalent annual cost) is an EPA requirement in performing the cost effectiveness analysis and serves as the primary cost evaluation criterion according to EPA guidelines.

### Cost Development

Construction, project and operation and maintenance costs are developed for all wastewater facilities in each management system.* Available local cost data, data from recent similar projects, standard costing sources and detailed engineering estimates are used in cost development. All costs are trended to 1981 price levels projected for the Mammoth Cave area.

### Present Worth Analysis

As previously noted, the alternative wastewater management systems are to be compared on the basis of their relative net present worth in accordance with EPA regulations. The present worth analysis establishes an estimated total cost value of the capital expenditures (project costs) and operating costs of each alternative over the duration of the planning period. For the purposes of this net present worth evaluation, construction of the wastewater facilities in the wastewater management alternatives is assumed to take place in 1983. Since the planning period ends with the year 2000, cost analyses are based upon a 17 year planning period. The discount rate used in the net present worth analysis is 7.125 percent. In accordance with EPA guidelines, allowances are made for salvage value at the end of the planning period. The discount rate used in the net present worth analysis is 7.125 percent. In accordance with EPA guidelines, allowances are made for salvage value at the end of the planning period. Also, phasing of construction is included in the analysis where applicable.

---

* Cost estimates for wastewater management are developed readily from detailed estimates prepared for the cost evaluation of local and joint wastewater treatment/disposal options. Since each of the wastewater management alternatives is composed of two or more recommended options, the estimated cost for any management alternative is the sum of the costs of wastewater facilities (collection, conveyance, treatment and disposal) associated with the recommended treatment/disposal options incorporated into that management alternative.

The present worth analysis of the eight wastewater management alternatives is presented in Table II-10. Based on net present worth, Alternative 8 (local treatment at each of the five population centers) is the least costly at 7.7 million. However, Alternative 5 (SA plus PC-2 plus (CC-HC) plus MN-1) provides for removing both Cave City and Horse Cave discharges from the subsurface with a net present worth increase of approximately $0.35 million or 11 percent. Another consideration is providing wastewater services to the Rt. 70 area. The least costly alternative involving service to this area is Alternative 7. This, however, represents a net present worth increase of approximately $2.2 million over Alternative 8 even accounting for 15% cost preference for (SA-CC) spray irrigation and pre-treatment facilities.

## 3. OPERABILITY EVALUATION

Evaluation of operability of the proposed wastewater management systems should include consideration of the following aspects:

- reliability of treatment
- flexibility of operation
- maintainability of facilities

In the evaluation of reliability the ability of the facilities in the treatment schemes to maintain the intended treatment levels is considered. Operational flexibility is a measure of the ability of wastewater treatment components to adopt to changes in wastewater characteristics and the ability of the wastewater management system to serve future development areas and to undergo upgrading and/or expansion to comply with changes in water quality goals. Maintainability considerations include the complexity of equipment, frequency of maintenance down time, and efficiency of providing required maintenance.

In order to provide a comparative operability ranking of the eight wastewater management alternatives, a numerical rating system is developed which combines ratings for each of the above factors into a total operability score. The rating system provides for a maximum possible operability score of 100 points. Flexibility, reliability and maintainability are weighted at thirty (30), forty (40) and thirty (30) points respectively, thus, indicating reliability to be the most significant factor. For any given alternative each operability factor is rated on a scale of 1 to 10, ten (10) being excellent and one (1) being poor. This rating is multiplied by the weighting proportion to determine the score. For example a reliability rating of 6, translates to a score of 24

$$\frac{(6}{(10} = \frac{24)}{10)}$$

## TABLE II-10
## PRESENT WORTH ANALYSIS
## UPDATE

| Wastewater Management Alternative | 1981 Project Cost | Annual O&M Costs | Present Worth Annual O&M Costs | Total Present Worth | Year 2000 Salvage Value | Present Worth Salvage Value | Net Present Worth | Cost Ranking |
|---|---|---|---|---|---|---|---|---|
| Alternative 1 (SA-PC-CC-HC)$^{2}$ plus MN-1 | 9,985,000 | 233,000 | 2,255,000 | 12,240,000 | 4,494,000 | 1,395,000 | 10,845,000 | 7 |
| Alternative 2 (PC-SA-CC-HC)$^{2}$ plus MN-1 | 10,574,000 | 261,000 | 2,527,000 | 13,101,000 | 4,770,000 | 1,481,000 | 11,620,000 | 8 |
| Alternative 3 SA plus (PC-CC-HC)$^{3}$, plus MN-1 | 8,804,000 | 237,000 | 2,294,000 | 11,098,000 | 4,007,000 | 1,244,000 | 9,854,000 | 5 |
| Alternative 4 PC-2 plus (SA-CC-HC)$^{3}$ plus MN-1 | 9,030,000 | 252,000 | 2,439,000 | 11,469,000 | 3,626,000 | 1,126,000 | 10,343,000 | 6 |
| Alternative 5 SA plus PC-2 plus (CC-HC)$^{8}$ plus MN-1 | 6,546,000 | 230,000 | 2,226,000 | 8,772,000 | 2,568,000 | 797,000 | 7,975,000 | 2 |
| Alternative 6 SA plus (PC-CC)$^{2}$ HC-4 plus MN-1$_{6}$, plus filters | 7,834,000<br>338,000<br>8,172,000 | 235,000<br>22,000<br>257,000 | 2,275,000<br>213,000<br>2,488,000 | 10,109,000<br>551,000<br>10,660,000 | 3,467,000<br>9,400<br>3,561,000 | 1,076,000<br>29,000<br>1,105,000 | 9,033,000<br>522,000<br>9,555,000 | 3 |
| Alternative 7 PC-2 plus (SA-CC) plus HC-4 plus MN-1 | 8,675,000 | 252,000 | 2,439,000 | 11,114,000 | 3,412,000 | 1,059,000 | 9,704,000 | 4 |

## TABLE II-10 (Cont'd.)
## PRESENT WORTH ANALYSIS
## UPDATE

| Wastewater Management Alternative | 1981 Project Cost | Annual O&M Costs | Present Worth Annual O&M Costs | Total Present Worth | Year 2000 Salvage Value | Present Worth Salvage Value | Net Present Worth | Cost Ranking |
|---|---|---|---|---|---|---|---|---|
| Alternative 8<br>SA plus PC-2<br>plus CC-3 plus<br>HC-4 plus MN-1 | 5,576,000 | 228,000 | 2,207,000 | 7,783,000 | 2,031,000 | 630,000 | 7,153,000 | 1 |
| plus filters** | 300,000 | 21,000 | 203,000 | 503,000 | 84,000 | 26,000 | 477,000 | |
| | 5,876,000 | 249,000 | 2,410,000 | 8,286,000 | 2,125,000 | 656,000 | 7,630,000 | |

* This net present worth is adjusted for 15% cost preference for (SA-CC) spray irrigation and pretreatment facilities.

** Filters are only considered for Cave City

Note: All costs have been developed to accommodate flows from Park City and National Park Service Staging Area

The basic assumptions used in determining operability ratings for wastewater management alternatives as follows:

- Facilities with lower treatment levels are more reliable and easier to maintain than those with higher treatment levels. However, on-lot systems are considered more difficult to maintain, even though treatment levels are low, because of the large number of individuals responsible for maintenance. However, if EPA funds on-lot systems a management maintenance program would be required. Such a program would minimize potential maintenance problems.

- Joint wastewater treatment/disposal is considered to be more flexible and reliable than local treatment/disposal but less maintainable because of the conveyance facilities (especially pumping stations) required.

- Composting waterless toilets are considered to be less reliable and maintainable than conventional systems because of their operational unknowns for large-scale usage. They are considered to be equally flexible as conventional systems.

- Spray irrigation of effluent is less reliable and flexible than discharge to surface waters. (This evaluation is based, in part, on the operational unknowns associated with the soils and topographic conditions at potential land application sites).

The results of the operability evaluation are presented in Table II-11. Wastewater management alternatives 1 and 2 are considered to be the most operable, each receiving a rating of 80. The high ratings are due partly to the fact that the systems are considered highly reliable since combining wastewaters from all the population centers reduces the chances of a discharge that greatly exceeds secondary treatment levels. In addition, these alternatives are considered highly reliable since only secondary treatment levels are to be maintained.

## 6. IMPLEMENTABILITY EVALUATION

The practicalities of implementing a specific wastewater management plan must be considered, together with cost, environmental impacts and operability evaluations, as an important part of the cost-effectiveness analysis. The purpose of the implementability rating is to assess the prospects for successful implementation of an alternative based on its potential for general public acceptance and political realities in the study area.

Unlike the other evaluation in the cost-effectiveness analysis (costs, environmental impacts & operability), the implementability rating is not independent, but is somewhat dependent on the results of

## TABLE II-11

### OPERABILITY EVALUATION COMPARISON
### MAMMOTH CAVE AREA WASTEWATER MANAGEMENT ALTERNATIVES

| Wastewater Management Alternative | Reliability | Flexibility | Maintainability | Total | Operability Ranking |
|---|---|---|---|---|---|
| Alternative 1 $(SA-PC-CC-HC)^2$, MN-1 | 32 | 24 | 24 | 80 | 1 |
| Alternative 2 $(PC-SA-CC-HC)^2$, MN-1 | 32 | 27 | 21 | 80 | 1 |
| Alternative 3 SA, $(PC-CC-HC)^3$, MN-1 | 38 | 18 | 21 | 67 | 3 |
| Alternative 4 PC-2, $(SA-CC-HC)^3$, MN-1 | 32 | 21 | 15 | 68 | 2 |
| Alternative 5 SA, PC-2, $(CC-HC)^5$, MN-1 | 24 | 15 | 18 | 57 | 5 |
| Alternative 6 SA, $(PC-CC)^2$, HC-4, MN-1 | 24 | 15 | 21 | 60 | 4 |
| Alternative 7 PC-2, (SA-CC), HC-4, MN-1 | 20 | 21 | 15 | 56 | 6 |
| Alternative 8 PC-2, SA, CC-3, HC-4, MN-1 | 20 | 12 | 18 | 50 | 7 |

the other evaluations. This is especially the case with public acceptance since costs and environmental impacts evaluations probably have the greatest influence on public acceptability. For example, if an environmentally favorable plan is significantly more costly, the public must decide how much it is willing to pay (in terms of monetary costs) for environmental benefits.

An important factor in public acceptance is the local annual cost associated with a wastewater management alternative. The local annual cost includes annual operation and maintenance costs plus the annualized local share of the cost of constructing the wastewater facilities. This is a measure of annual revenue requirements, and therefore, the actual cost to the users. Since construction costs are 75 percent federally funded and local operation and maintenance costs are not subsidized, projects with high construction and low operation and maintenance costs sometimes have lower local annual costs even though they are higher on a net present worth basis than other plans with greater operation and maintenance costs and lower construction costs.

Table II-12 presents a breakdown of estimated annual costs, by population center [1] for each wastewater management alternative. The assumptions for developing these local annual costs are as follows:

- All project costs are considered to be grant eligible with the exception of interest during construction (5 percent of construction costs). Collectors are eligible but generally not fundable.

- Construction costs for individual on-lot systems are grant eligible if certain conditions are met. (See PRM 79-8)

- Spray irrigation and pre-treatment facilities are eligible for 85% funding.

- The Staging Area (National Park Service) is not eligible for an EPA grant and bears 100 percent of its share of construction costs.

- For joint treatment disposal, each participating population center pays a percentage of local annual costs (based on estimated design flows) for only those wastewater facilities that handle its wastewaters.

Rankings of alternatives based on total local annual costs and local annual costs excluding the National Park Staging Area are presented in Table II-13.

Through the series of Citizen Review Committee meetings held in the study area it has become clear that environmental protection of

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[1] The Rt. 70 development area is listed as a population center since it is expected that this area will pay its share of the costs for wastewater facilities if included in the service area of a wastewater management system.

### TABLE II-12
### WASTEWATER MANAGEMENT ALTERNATIVES
### LOCAL ANNUAL COSTS BY POPULATION CENTER

| | Alternative 1 | Alternative 2 | Alternative 3 | Alternative 4 | Alternative 5 | Alternative 6 | Alternative 7 | Alternative 8 |
|---|---|---|---|---|---|---|---|---|
| *Staging Area | 234,000 | 162,000 | 42,000 | 201,000 | 42,000 | 42,000 | 187,000 | 42,000 |
| Park City | 128,000 | 149,000 | 150,000 | 50,000 | 50,000 | 144,000 | 50,000 | 50,000 |
| Cave City | 131,000 | 123,000 | 134,000 | 129,000 | 143,000 | 124,000 | 96,000 | 128,000 |
| Horse Cave | 141,000 | 139,000 | 141,000 | 140,000 | 145,000 | 158,000 | 158,000 | 158,000 |
| Munfordville | 56,000 | 56,000 | 56,000 | 56,000 | 56,000 | 56,000 | 56,000 | 56,000 |
| Rt. 70 Development | - | 50,000 | - | 57,000 | - | - | 51,000 | - |
| | 690,000 | 679,000 | 523,000 | 633,000 | 436,000 | 524,000 | 598,000 | 434,000 |

---

*EPA Construction Grants are not available for federal facilities contributing greater than 5 percent of the total flow (EPA PRM 75-35, December 29, 1978).

## TABLE II-13
## WASTEWATER MANAGEMENT ALTERNATIVES
## LOCAL ANNUAL COSTS RANKING

| | Total Annual Local Costs | Ranking | Local Annual Costs Excluding the National Park Staging Area | Ranking |
|---|---|---|---|---|
| Alternative 1<br>(SA-PC-CC-HC)$^{2}$, MN-1 | $690,000 | 8 | $456,000 | 5 |
| Alternative 2<br>(PC-SA-CC-HC)$^{2}$, MN-1 | 678,000 | 7 | 517,000 | 8 |
| Alternative 3<br>SA, (PC-CC-HC)$^{3}$, MN-1 | 523,000 | 3 | 481,000 | 6 |
| Alternative 4<br>PC-2, (SA-CC-HC)$^{3}$, MN-1 | 633,000 | 6 | 432,000 | 4 |
| Alternative 5<br>SA, PC-2, (CC-HC)$^{8}$, MN-1 | 436,000 | 2 | 394,000 | 2 |
| Alternative 6<br>SA, (PC-CC)$^{2}$, HC-4, MN-1 | 524,000 | 4 | 482,000 | 7 |
| Alternative 7<br>PC-2, (SA-CC), HC-4, MN-1 | 598,000 | 5 | 411,000 | 3 |
| Alternative 8<br>SA, PC-2, CC-3, HC-4, MN-1 | 434,000 | 1 | 392,000 | 1 |

the local natural resources such as the complex cave systems and subsurface streams are of paramount concern. There is considerable sentiment from the local community, the National Park Service and cave research and exploration groups that the area must be protected from further intrusions of wastewater. This clearly means utilizing a regional alternative to remove all wastewater from the area.

This solution is more expensive since it means conveying all treated wastewater to the Green River. However, based upon local reaction and input, cost considerations do not appear to be an important barrier. The only exception is Park City where sewer rental rates would clearly be beyond the ability of many local residents to pay based upon cost estimates.

Financial considerations and their impacts are an important consideration in this area. Per capita incomes and median family incomes are well below national and state levels. Clearly, high sewer rentals would have a profound financial impact upon the residents of the study area. However, it is also clear that the residents of the area seek to resolve their wastewater problems and protect the area's valuable natural resources.

To develop a scenario of the financial impacts upon the study area, estimated annual user charges have been developed for each population center in the study area. These include: Park City, Cave City, Horse Cave, Munfordville, National Park Service Staging Area, and Rt. 70 Development.

The estimated annual user charges present a general range of potential user costs. Actual user costs would not be determined until the project is under construction. Only at that point would the actual annual local costs and debt service be known. However, Tables II-14 through II-19 have been developed to provide Annual User Charges/Equivalent Dwelling Unit (EDU). These are developed for each population center.

User charges are basically developed by using the following formula:

$$\text{User Charges} = \frac{\text{Annual Local Costs After Grant}}{\text{Number of EDU's}}$$

Annual local costs after the grant are developed combining the annual cost of operations and maintenance plus the debt service on the local share of the project. This is based upon a payback period of 17 years at a 7.125% interest rate.

EDU's represent the average residential user. Other users such as commercial and industrial may be represented in terms of number of EDU's. EDU's are based upon the total water consumption divided by estimated typical dwelling unit consumption.

## TABLE II-14
## PARK CITY COST ESTIMATES

| Alternative | Project Costs | Annual O&M Costs | Total Present Worth | Local Annual Cost (with grant) | Annual User Charges ($/EDU) |
|---|---|---|---|---|---|
| Alternative 1 (SA-PC-CC-HC)[2], MN-1 | 3,380,000 | 27,000 | 3,641,000 | 128,000 | $365-425 |
| Alternative 2 (PC-SA-CC-HC)[2], MN-1 | 3,652,000 | 40,000 | 4,039,000 | 149,000 | $425-495 |
| Alternative 3 SA, (PC-CC-HC)[3], MN-1 | 3,847,000 | 35,000 | 4,186,000 | 150,000 | $430-500 |
| Alternative 4 PC-2, (SA-CC-HC)[3], MN-1 | 1,249,000 | 26,000 | 1,501,000 | 50,000 | $145-165 |
| Alternative 5 SA, PC-2(CC-HC)[3], MN-1 | 1,249,000 | 26,000 | 1,501,000 | 50,000 | $145-165 |
| Alternative 6 SA, (PC-CC)[2], HC-4, MN-1 | 3,569,000 | 37,000 | 3,927,000 | 144,000 | $410-480 |
| Alternative 7 PC-2 (SA-CC), HC-4, MN-1 | 1,249,000 | 26,000 | 1,501,000 | 50,000 | $145-165 |
| Alternative 8 PC-2, SA, CC-3, HC-4, MN-1 | 1,249,000 | 26,000 | 1,501,000 | 50,000 | $145-157 |

Assuming approximately 300-350 EDU's

NOTES: 1. Assumes 75% funding for conventional collection systems. However, conventional collection systems are generally not funded. If low pressure systems are funded at 85% user charges are increased by approximately 5%.

2. Includes estimated present worth of costs for on-lot systems constructed during the planning period. These costs assumed ineligible for grant.

## TABLE II-15

## CAVE CITY COST ESTIMATES

| Alternative | Project Costs | Annual O&M Costs | Total Present Worth | Local Annual Cost (with grant) | Annual User Charges ($/EDU) |
|---|---|---|---|---|---|
| Alternative 1<br>(SA-PC-CC-HC)$^{2}$,<br>MN-1 | 1,992,000 | 71,000 | 2,679,000 | 131,000 | $73 |
| Alternative 2<br>(PC-SA-CC-HC)$^{2}$,<br>MN-1 | 1,835,000 | 68,000 | 2,493,000 | 123,000 | $68 |
| Alternative 3<br>SA, (PC-CC-HC)$^{3}$,<br>MN-1 | 2,101,000 | 71,000 | 2,788,000 | 134,000 | $74 |
| Alternative 4<br>PC-2, (SA-CC-HC)$^{3}$,<br>MN-1 | 1,959,000 | 70,000 | 2,637,000 | 129,000 | $72 |
| Alternative 5<br>SA, PC-2, (CC-HC)$^{8}$,<br>MN-1 | 2,340,000 | 73,000 | 3,047,000 | 143,000 | $79 |
| Alternative 6<br>SA, (PC-CC)$^{2}$,<br>HC-4, MN-1 | 1,265,000 | 86,000 | 2,097,000 | 124,000 | $69 |
| Alternative 7<br>PC-2, (SA-CC),<br>HC-4, MN-1 | 1,378,000 | 69,000 | 2,046,000 | 96,000 | $53 |
| Alternative 8<br>PC-2, SA, CC-3,<br>HC-4, MN-1 | 1,287,000 | 89,000 | 2,149,000 | 128,000 | $71 |

Assuming approximately 1800 EDU's

* Does not include existing user charges. Estimated existing user charges are $45/EDU/year.

## TABLE II- 16

## HORSE CAVE COST ESTIMATES

| Alternative | Project Costs | Annual O&M Costs | Total Present Worth | Local Annual Cost (with grant) | Annual User Charges ($/EDU) |
|---|---|---|---|---|---|
| Alternative 1<br>(SA-PC-CC-HC)$^{2}$,<br>MN-1 | 1,786,000 | 87,000 | 2,628,000 | 141,000 | $39 |
| Alternative 2<br>(PC-SA-CC-HC)$^{2}$,<br>MN-1 | 1,752,000 | 87,000 | 2,594,000 | 139,000 | $39 |
| Alternative 3<br>SA, (PC-CC-HC)$^{3}$,<br>MN-1 | 1,793,000 | 87,000 | 2,635,000 | 141,000 | $39 |
| Alternative 4<br>PC-2, (SA-CC-HC)$^{3}$,<br>MN-1 | 1,767,000 | 87,000 | 2,609,000 | 140,000 | $39 |
| Alternative 5<br>SA, PC-2, (CC-HC)$^{3}$,<br>MN-1 | 1,895,000 | 88,000 | 2,747,000 | 145,000 | $40 |
| Alternative 6<br>SA, (PC-CC)$^{2}$,<br>HC-4, MN-1 | 2,278,000 | 90,000 | 3,149,000 | 158,000 | $44 |
| Alternative 7<br>PC-2, (SA-CC),<br>HC-4, MN-1 | 2,278,000 | 90,000 | 3,149,000 | 158,000 | $44 |
| Alternative 8<br>PC-2, SA, CC-3,<br>HC-4, MN-1 | 2,278,000 | 90,000 | 3,149,000 | 158,000 | $44 |

Assuming approximately 3600 EDU's

* Does not include existing user charges. Estimated existing user charges are $37/EDU/year.

## TABLE II-17

## MUNFORDVILLE COST ESTIMATES

| Alternative | Project Costs | Annual O&M Costs | Total Present Worth | Local Annual Cost (with grant) |
|---|---|---|---|---|
| Alternative 1<br>(SA-PC-CC-HC)[2],<br>MN-1 | 776,000 | 26,000 | 822,000 | 56,000 |
| Alternative 2<br>(PC-SA-CC-HC)[2],<br>MN-1 | 570,000 | 26,000 | 822,000 | 56,000 |
| Alternative 3<br>SA, (PC-CC-HC)[3],<br>MN-1 | 776,000 | 26,000 | 822,000 | 56,000 |
| Alternative 4<br>PC-2, (SA-CC-HC)[3],<br>MN-1 | 776,000 | 26,000 | 822,000 | 56,000 |
| Alternative 5<br>SA, PC-2, (CC-HC)[8],<br>MN-1 | 776,000 | 26,000 | 822,000 | 56,000 |
| Alternative 6<br>SA, (PC-CC)[2],<br>HC-4, MN-1 | 776,000 | 26,000 | 822,000 | 56,000 |
| Alternative 7<br>PC-2, (SA-CC),<br>HC-4, MN-1 | 776,000 | 26,000 | 822,000 | 56,000 |
| Alternative 8<br>PC-2, SA, CC-3,<br>HC-4, MN-1 | 776,000 | 26,000 | 822,000 | 56,000 |

1. Includes estimated present worth of costs for on-lot systems constructed during the planning period. These costs assumed ineligible for grant.

## TABLE II- 18

## STAGING AREA COST ESTIMATES

| Alternative | Project Costs | Annual O&M Costs | Total Present Worth | Local Annual Cost (with grant) |
|---|---|---|---|---|
| Alternative 1<br>(SA-PC-CC-HC)$^{2}$,<br>MN-1 | 2,046,000 | 23,000 | 2,269,000 | 234,000 |
| Alternative 2<br>(PC-SA-CC-HC)$^{2}$<br>MN-1 | 1,297,000 | 28,000 | 1,568,000 | 162,000 |
| Alternative 3<br>SA, (PC-CC-HC)$^{3}$,<br>MN-1 | 285,000 | 13,000 | 411,000 | 42,000 |
| Alternative 4<br>PC-2, (SA-CC-HC)$^{3}$,<br>MN-1 | 1,653,000 | 30,000 | 1,943,000 | 201,000 |
| Alternative 5<br>SA, PC-2 (CC-HC)$^{8}$,<br>MN-1 | 285,000 | 13,000 | 411,000 | 42,000 |
| Alternative 6<br>SA, (PC-CC)$^{2}$,<br>HC-4, MN-1 | 285,000 | 13,000 | 411,000 | 42,000 |
| Alternative 7<br>PC-2, (SA-CC),<br>HC-4, MN-1 | 1,524,000 | 30,000 | 1,814,000 | 187,000 |
| Alternative 8<br>PC-2, SA, CC-3,<br>HC-4, MN-1 | 285,000 | 13,000 | 411,000 | 42,000 |

## TABLE II- 19

## RT. 70 AREA COST ESTIMATES

| Alternative | Project Costs | Annual O&M Costs | Total Present Worth | Local Annual Cost (with grant) |
|---|---|---|---|---|
| Alternative 1<br>(SA-PC-CC-HC)$^{2}$,<br>MN-1 | - | - | - | - |
| Alternative 2<br>(PC-SA-CC-HC)$^{2}$,<br>MN-1 | 1,259,000 | 12,000 | 1,375,000 | 50,000 |
| Alternative 3<br>SA, (PC-CC-HC)$^{3}$,<br>MN-1 | - | - | - | - |
| Alternative 4<br>PC-2, (SA-CC-HC)$^{3}$,<br>MN-1 | 1,653,000 | 30,000 | 1,943,000 | 57,000 |
| Alternative 5<br>SA, PC-2, (CC-HC)$^{8}$,<br>MN-1 | - | - | - | - |
| Alternative 6<br>SA, (PC-CC)$^{2}$,<br>HC-4, MN-1 | - | - | - | - |
| Alternative 7<br>PC-2, (SA-CC),<br>HC-4, MN-1 | 1,354,000 | 13,000 | 1,480,000 | 51,000 |
| Alternative 8<br>PC-2, SA, CC-3,<br>HC-4, MN-1 | - | - | - | - |

All user charges represent annual costs in addition to existing changes presently being paid for sewer rentals. With the exception of Park City, none of the annual user charges appear to be exborbitant. Park City would be significantly effected by any new wastewater facilities constructed for that community. This is due to a small population being asked to support a new sewer system. Depending on which wastewater management alternative is considered, annual user charges vary from $145/EDU/year to $500/EDU/year.

The local communities and the National Park Service are aware that the natural resources of the area need protection. Furthermore their protection is important to the area since most of the area's economy is dependent upon the continuing viability of cave resources as a source of tourism.

Another aspect of implementability is the ownership and operation of the new wastewater facilities. Several options are being considered by the local communities. However it appears that a local service authority will be formed by the communities of Horse Cave and Cave City. This authority would have responsibility for ownership and operation of the new conveyance facilities recommended in the preferred alternative. They would generate revenues from rentals charged to Horse Cave and Cave City for the use of the conveyance systems.

## PART F. NO-ACTION ALTERNATIVE EVALUATION

A requirement of the EIS process developed by EPA is that a no-action alternative will be considered along with other wastewater facilities alternatives. The no-action alternative implies that no federal funding would be available for wastewater facilities in the Mammoth Cave area. Under this alternative, improvement and/or expansion of the wastewater facilities would be required but there would be no federal funds provided for design and construction of the facilities.

A no-action alternative does not imply no-growth. Growth would continue but any wastewater functions would be supported by private capital, or local and state funding. However, a no-action alternative could possibly alter growth throughout the area. Under the concept of no action there would be complete reliance upon state, local or private funds to finance any wastewater management facilities. However, without the support of federal funds, the level of additional wastewater facilities would be significantly different than under any of the other wastewater management alternatives.

Under a no-action scenario it is likely that most future sewage treatment and disposal needs would be accommodated by either privately owned package treatment plants or individual on-lot treatment systems. It is unlikely that any of the communities in the study area would be financially able to undertake any significant expansion of their wastewater facilities. This alternative would impact the rate of growth, the pattern of growth and the overall cost of wastewater management.

The missing component in this alternative is the federal share of capital funding for wastewater management. Considering the magnitude of the capital cost of any structural wastewater management systems for the basin, it is highly unlikely that any such system could be constructed if 100% of the cost had to be borne by state and local governments. A review of the cost of the 8 wastewater management alternative reveals that alternative 8, the so-called "local alternative" has the least net present worth of $7,695,000. However, the local communities in the study area would be hard pressed to finance even this level of funding. Despite these problems, it is reasonable to expect that other methods of sewage treatment would emerge in response to development pressures.

A no-action alternative would most likely constrain activity by the local municipalities to either upgrade or expand their facilities. The following is a portrayal of the impacts of a no-action alternative on each community in the study area.

Horse Cave. The major problems at Horse Cave are associated with the industrial wastewater discharged into the plant. This results in poor treatment and, therefore, degradation of the entire Hidden River Cave environment. Under a no-action scenario we would assume that the major improvements to the plant would be through operation and maintenance of the present plant. However, the community could take action to resolve the industrial waste problem by instituting and enforcing a strong sewer use ordinance and restricting the loadings from both Ken-Dec and the Hart County Creamery. With the industrial waste problem resolved, treatment levels at the plant would improve, but not to the degree necessary to be consistent with the waste load allocations. However, under this alternative, disposal would continue into the Hidden River complex and would not resolve the environmental conflicts which occur in that cave system.

There is some excess capacity at the Horse Cave treatment plant which would be available for limited residential or industrial development. However, most new growth would require the use of on-lot systems which, in turn, would have a further negative environmental impact upon the study area.

Munfordville. A no-action alternative would most likely have little influence upon Munfordville. Proposed expansion of the collection system might be sacrificed although the community may elect to finance this program locally. However, it is more likely that a no-action alternative would cause a proliferation of conventional and alternate on-lot wastewater treatment and disposal systems.

Cave City. The Cave City wastewater treatment plant is currently not providing the level of treatment required by the NPDES permit. According to the EIS analysis of the plant, operations improvements are necessary to maintain secondary treatment levels, but significant process changes are required to meet NPDES permit conditions.

Under a no-action scenario it is unlikely that funds would be available to undertake any process changes, therefore the plant would continue to operate in violation of the NPDES permit. This will continue to adversely impact the Hidden River Cave system which received the treated effluent from the Cave City treatment plant. Flow records from 1977 indicate that the plant was approximately 0.1 mgd less than the plant's design capacity of 0.32 mgd. This would allow additional capacity for residential and commercial development especially that associated with the tourism industry in the area.

Park City. The impact upon Park City of a no-action alternative would be practically negligible, since the community only has on-lot systems. Therefore, the community would continue to utilize its on-lot systems for existing development and for any new development. However, the continuation of existing wastewater disposal practices would potentially impact subsurface water resources in or near Mammoth Cave National Park.

In summary, the selection of a no-action alternative would generate the following conditions:

1. Little or no changes in the existing sewage treatment systems. Operational changes could be made but process changes would be beyond the financial capabilities of the communities. Proliferation of conventional or alternative on-lot disposal systems.

2. Continuation of environmental degradation in the Hidden River Cave complex from inadequately treated wastewater from improperly designed, installed, and operated on-lot systems.

3. Restrictions on residential, commercial and industrial development. Proliferation of package treatment plants and on-lot systems. No-action will also stimulate strip development and scatter development.

## PART 6. DESCRIPTION OF THE PREFERRED ALTERNATIVE

The underlying theme of the EIS is that the provision of wastewater services should be compatible with efforts to preserve and protect this area's nationally significant cave systems and their unique physical, biological and historical resources. It is therefore incumbent upon EPA to explore all available mechanisms to achieve an environmentally sound alternative that is sensitive to economic realities. The selection of the least costly alternative is not EPA's only aim, but rather the selection of an environmentally protective alternative that is locally affordable. In this regard, a regional system is viewed as the environmentally preferred option. However, local economic constraints dictate that other environmentally acceptable options be pursued.

In light of the concerns regarding cost and the protection of the cave resources, the approach recommended by EPA is a phased approach which, depending on local decisions, will ultimately result in a regional (Alternative 2) or semi-regional (Alternative 5) wastewater management system.

This approach would involve the following components:

1. Initiate Phase I of the project which would provide for design for upgrading the treatment facilities at Cave City (0.37 MGD) and Horse Cave (0.53 MGD) and for conveyance facilities to the Green River. The conveyance facilities would be evaluated with and without future flows from Park City (0.08 MGD), the proposed Mammoth Cave National Park Staging Area (0.105 MGD), and the Route 70 area.

2. The establishment of a critical decision date to coincide with completion of the preliminary design for Horse Cave and Cave City for the NPS's decision regarding the development of the proposed Staging Area or the local communities' commitment to obtain additional non-EPA funding sources.

3. Provide final design for facilities based on the above decisions. At that point, EPA and the Commonwealth of Kentucky will also have to define the extent of EPA eligibility for remaining design and construction.

   a. If the NPS does develop the Staging Area and is able to provide significant funding assistance for Park City or additional non-EPA funds are available, the remaining components of the regional alternative could be constructed. These construction elements would involve treatment facilities at Park City and the Mammoth Cave National Park Staging Area, conveyance facilities from Park City to the Staging Area along Route 70 to Cave City and expand Cave City's facility to 0.58 MGD. This would, in essence, be Alternative 2.

   b. If the NPS does not develop the proposed Staging Area or additional non-EPA funds are not available, the remaining components of a semi-regional alternative would be constructed. This construction element would involve on-lot systems for Park City's residential areas and a community sub-surface absorption field for the Park City business district. Presently available funding mechanisms would allow for EPA participation in the cost of these activities but would be contingent on Congressional continuation of these mechanisms. Also, funding would have to be in accordance with the State Priority list. This would, in essence, be Alternative 5.

The regional alternative is most responsive to local and the NPS desires regarding protection of the groundwater and the cave systems. However, because of high cost and the resultant financial burden to be seen locally, the regional alternative may not be viable at this time. Local funding decisions to be made in the near future are critical to the ultimate wastewater management system for this area. Additional non-EPA funds must be available for a regional system to be affordable to Park City. Until the appropriate decisions related to NPS funding or other non-EPA financial assistance are made, EPA should move to resolve existing wastewater management and water quality problems. In essence, the proposed phased approach would allow for resolving the current more serious problems while remaining flexible to future local funding decisions. Figure II-11 describes the proposed strategy for wastewater management in the study area.

## 1. EFFLUENT LIMITS

Under the preferred action, all treated wastewater from Horse Cave and Cave City would be conveyed to the Green River for disposal. Because of the large 7 day, 10 year low flow, approximately 160 cfs, effluent limitations for the Green River only require secondary treatment levels. This would mean a discharge of 30 mg/l of suspended solids and 30 mg/l of $BOD_5$.

## 2. DESCRIPTION OF PROPOSED FACILITIES

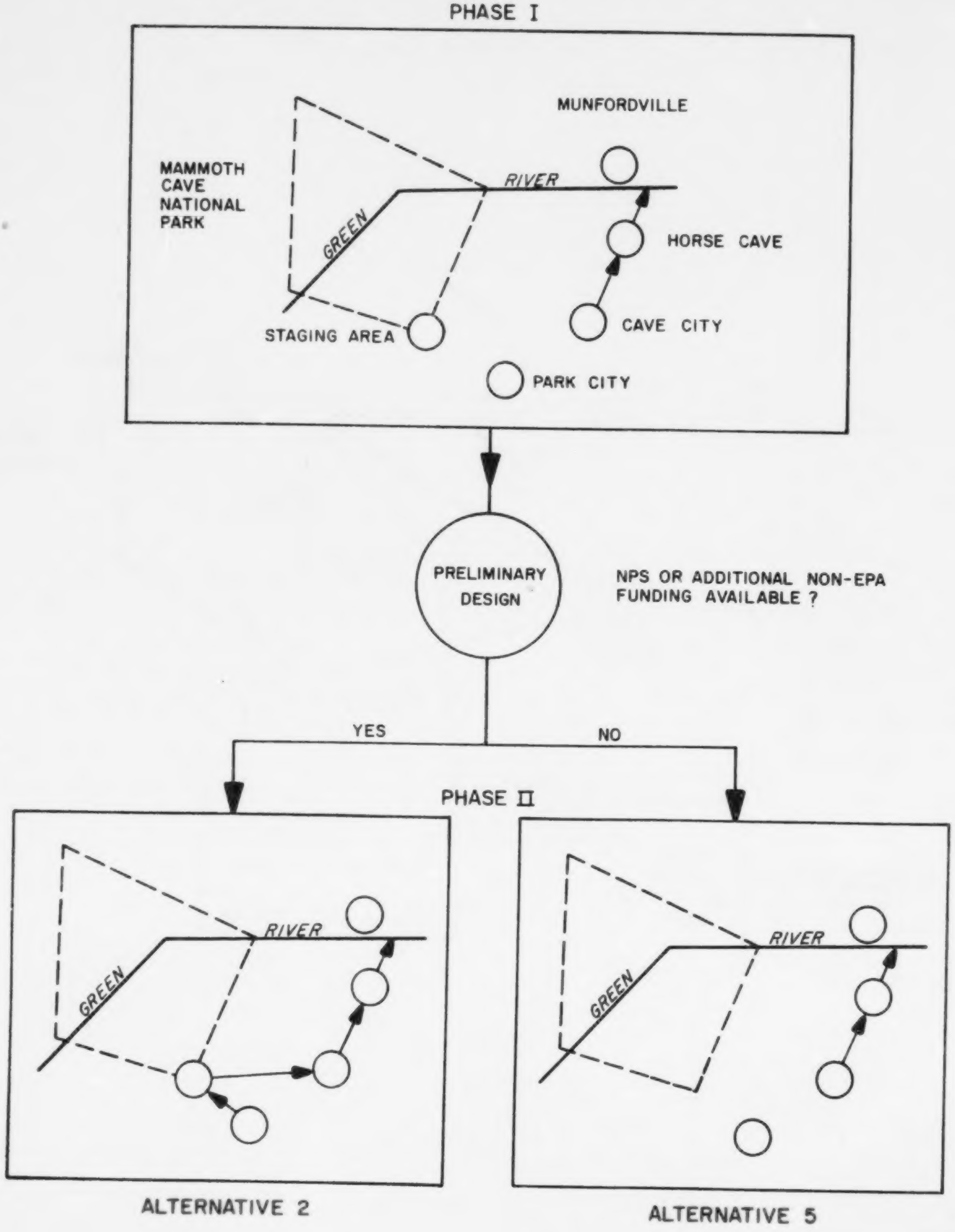
Horse Cave - The Horse Cave wastewater treatment facility is a high-rate trickling filter plant designed for a hydraulic loading of 0.4 mgd and a $BOD_5$ loading of approximately 870 lbs/day. Major wastewater treatment processes include grit removal, comminution, primary sedimentation, trickling filtration, secondary sedimentation and chlorination. According to the 201 Wastewater Facilities Plan the Horse Cave plant is capable of producing an effluent $BOD_5$ of approximately 50 mg/l is operated at optimum efficiency. (This is contingent on adequate pre-treatment of industrial wastewater.)

Since the existing facility is capable of providing substantial $BOD_5$ removal, it appears that a second stage biological treatment step in series with existing trickling filter process is the most appropriate method of treatment for upgrading plant effluent. Therefore it is recommended that an activated sludge second stage biological treatment step be added to the process train. In addition, a new secondary clarifier is also recommended. A flow equalization basin is also recommended to handle industrial flow eminating from Ken Dec. Figure II-12 provides the general process for upgrading the Horse Cave Wastewater Treatment Plant.

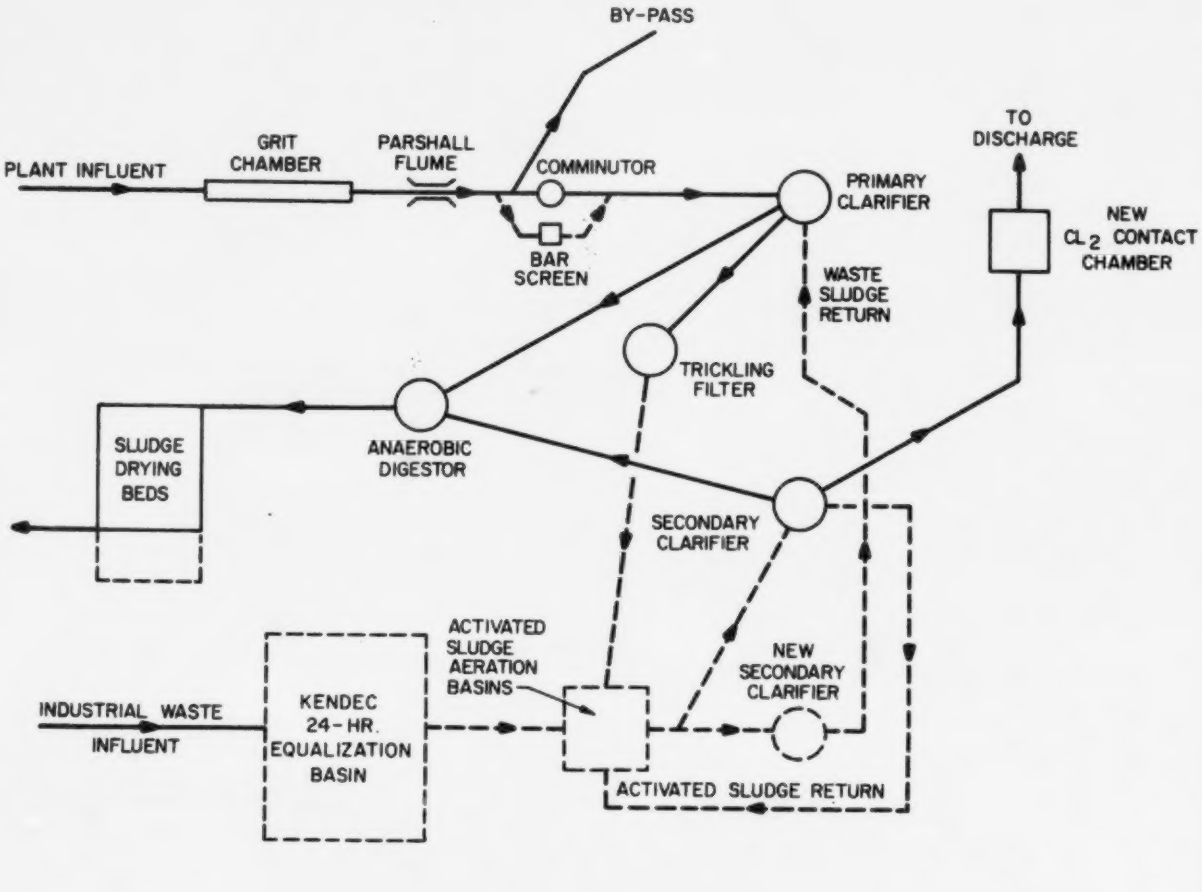
Cave City - The Cave City treatment plant provides biological wastewater treatment by means of high-rate trickling filter with a design capacity of 0.32 mgd. The Cave City treatment plant would also be upgraded to provide secondary level treatment through the addition of activated sludge and a new secondary clarifier to the existing process

## FIGURE II-11

## MAMMOTH CAVE AREA
## PREFERRED STRATEGY FOR WASTEWATER MANAGEMENT


PHASE I
MUNFORDVILLE
MAMMOTH CAVE NATIONAL PARK
RIVER
GREEN
HORSE CAVE
CAVE CITY
STAGING AREA
PARK CITY
PRELIMINARY DESIGN
NPS OR ADDITIONAL NON-EPA FUNDING AVAILABLE ?
YES
NO
PHASE II
RIVER
GREEN
RIVER
GREEN
ALTERNATIVE 2
ALTERNATIVE 5

# GENERAL PROCESS FOR UPGRADING HORSE CAVE WASTEWATER TREATMENT PLANT



BY-PASS
PLANT INFLUENT
GRIT CHAMBER
PARSHALL FLUME
COMMINUTOR
BAR SCREEN
PRIMARY CLARIFIER
TO DISCHARGE
NEW $CL_2$ CONTACT CHAMBER
WASTE SLUDGE RETURN
TRICKLING FILTER
SLUDGE DRYING BEDS
ANAEROBIC DIGESTOR
SECONDARY CLARIFIER
ACTIVATED SLUDGE AERATION BASINS
NEW SECONDARY CLARIFIER
INDUSTRIAL WASTE INFLUENT
KENDEC 24-HR. EQUALIZATION BASIN
ACTIVATED SLUDGE RETURN

PROPOSED ADDITIONS FOR UPGRADING

II-74.b

FIGURE II-12

train. Figure II-13 provides the general process for upgrading the Cave City Wastewater Treatment Plant.

Park City - Under this preferred alternative, Park City would have two options. If the national Park Service develops the Staging Area and provides funding assistance or, if additional non-EPA funding assistance is available than a treatment facility would bon constructed at Park City. However, if there is no participation, then Park City could utilize the option of a community low pressure sewer system for collection and a community soil absorption field for the downtown area. Outlying areas would utilize on-lot systems.

Conveyance Facilities - Under the preferred alternative several pumping stations and force mains would be constructed to convey wastewater. A pumping station would be built at the Cave City treatment plant to convey wastewater from Cave City to Horse Cave via a force main. Another pumping station would be constructed at the Horse Cave treatment plant to convey the combined flows of Cave City and Horse Cave to the Green River. This would be via a force main to the Green River when disposal would take place.

If the National Park Service participated in the preferred alternative, a pumping station would be constructed at Park City to convey wastewater via a force main to the NPS Staging area. From there, wastewater would be pumped via force main to the Cave City treatment plant.

Costing - Initial costing of the wastewater alternatives for this EIS was prepared in mid-1979. However, for the development of the preferred alternative, costs have been updated to 1981 to provide a reasonable estimate of current costs. Table II-14 provides a present worth analysis estimated local annual costs, and estimated annual user costs for the preferred alternative. The following assumptions were made in updating these costs:

1. Project and O&M costs were increased by 14% to reflect changes in the EPS sewage treatment construction cost index.
2. Planning period reduced to 17 years and discount rate increased from 6.875% to 7.125%.

# GENERAL PROCESS FOR UPGRADING CAVE CITY WASTEWATER TREATMENT PLANT

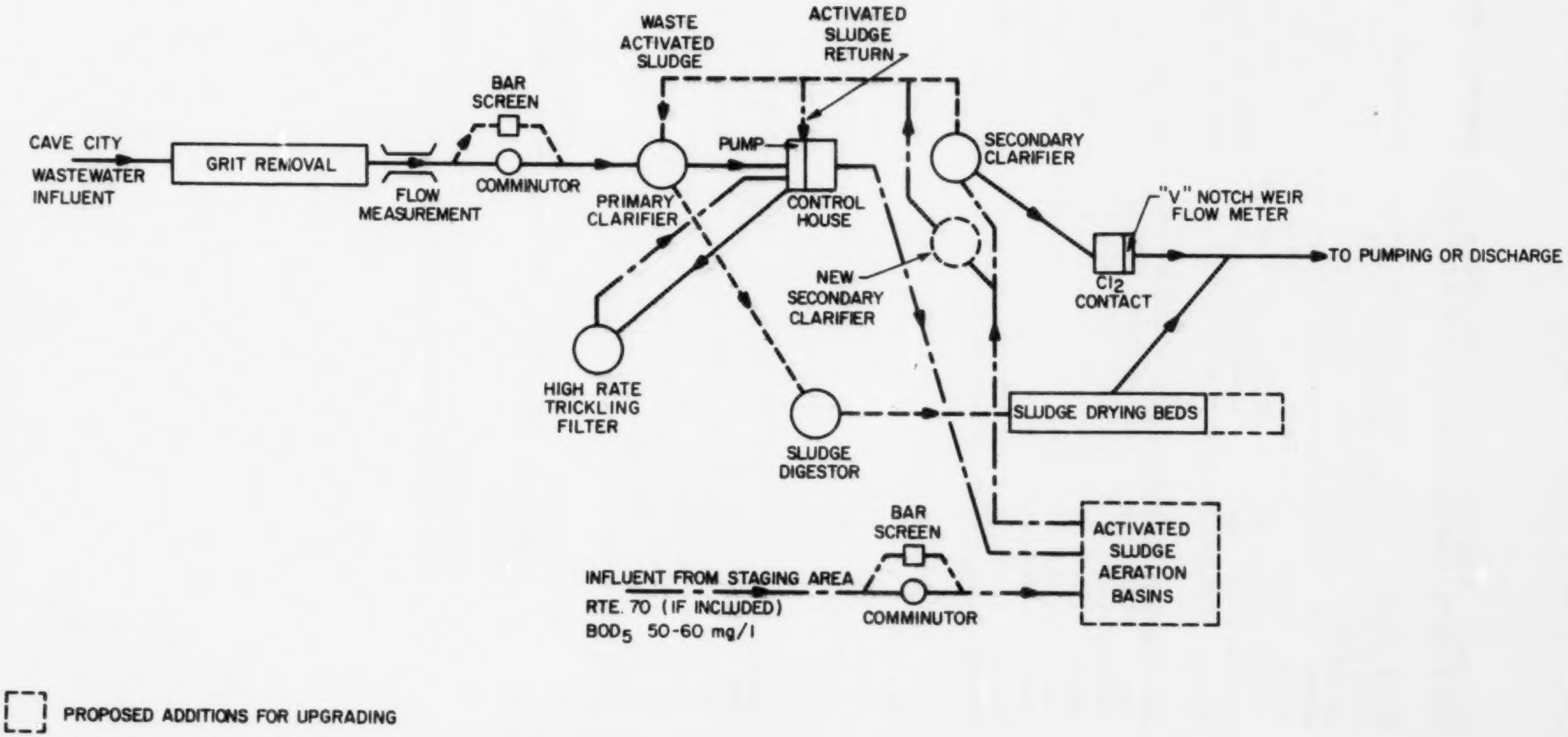

CAVE CITY WASTEWATER INFLUENT
GRIT REMOVAL
FLOW MEASUREMENT
BAR SCREEN
COMMINUTOR
WASTE ACTIVATED SLUDGE
PRIMARY CLARIFIER
PUMP
ACTIVATED SLUDGE RETURN
CONTROL HOUSE
HIGH RATE TRICKLING FILTER
SLUDGE DIGESTOR
NEW SECONDARY CLARIFIER
SECONDARY CLARIFIER
"V" NOTCH WEIR FLOW METER
Cl2 CONTACT
TO PUMPING OR DISCHARGE
SLUDGE DRYING BEDS
ACTIVATED SLUDGE AERATION BASINS
INFLUENT FROM STAGING AREA
RTE. 70 (IF INCLUDED)
BOD5 50-60 mg/l
BAR SCREEN
COMMINUTOR
PROPOSED ADDITIONS FOR UPGRADING

FIGURE II-13

## TABLE II-20
## PREFERRED ALTERNATIVE COST SUMMARY

### Present Worth Analysis

| Wastewater Management Alternative | 1981 Project Cost | Annual O&M Costs | Present Worth Annual O&M Costs | Total Present Worth | Year 2000 Salvage Value | Present Worth Salvage Value | Net Present Worth |
|---|---|---|---|---|---|---|---|
| Alternative 2 (PC-SA-CC-HC)$^2$ plus MN-1 | 10,574,000 | 261,000 | 2,527,000 | 13,101,000 | 4,770,000 | 1,481,000 | 11,620,000 |
| Alternative 5 SA plus PC-2 plus (CC-HC)$^8$ plus MN-1 | 6,546,000 | 230,000 | 2,226,000 | 8,772,000 | 2,568,000 | 797,000 | 7,975,000 |

### Estimated Local Annual Costs

| Wastewater Management Alternative | Construction Costs | Project Costs | Assumed Grant Eligible Project Costs | Anticipated Grants | Local Share Project Costs | Annual Debt Service | Annual O&M Costs | Local Annual Costs |
|---|---|---|---|---|---|---|---|---|
| Alternative 2 (PC-SA-CC-HC)$^2$ plus MN-1 | 8,333,000 | 10,574,000 | 8,615,000 | 6,518,000 | 2,756,000 | 417,000 | 261,000 | 678,000 |
| Alternative 5 SA plus PC-2 plus (CC-HC)$^8$ plus MN-1 | 5,110,000 | 6,546,000 | 5,769,000 | 4,502,000 | 1,758,000 | 210,000 | 226,000 | 436,000 |

## TABLE II-20 (Cont'd.)
## PREFERRED ALTERNATIVE COST SUMMARY

### Estimated Annual User Costs

| | Park City | | | | Cave City | | | |
|---|---|---|---|---|---|---|---|---|
| Wastewater Management Alternative | 1981 Project Costs | Annual O&M Costs | Total Annual Local Costs (with grant) | Annual User Costs | Project Costs | Annual O&M Costs | Total Annual Local Costs (with grant) | Annual User Costs |
| Alternative $2_2$ (PC-SA-CC-HC)$^2$ plus MN-1 | 3,652,000 | 40,000 | 149,000 | $425-495 | 1,835,000 | 68,000 | 123,000 | $68 |
| Alternative 5 SA plus PC-$^2$ plus (CC-HC)$^8$ plus MN-1 | 1,249,000 | 26,000 | 50,000 | $145-165 | 2,340,000 | 73,000 | 143,000 | $79 |

| | Horse Cave | | | |
|---|---|---|---|---|
| Wastewater Management Alternative | 1981 Project Costs | Annual O&M Costs | Total Annual Local Costs (with grant) | Annual User Costs |
| Alternative $2_2$ (PC-SA-CC-HC)$^2$ plus MN-1 | 1,752,000 | 87,000 | 139,000 | $39 |
| Alternative 5 SA plus PC$_8^2$ plus (CC-HC) plus MN-1 | 1,895,000 | 88,000 | 145,000 | $40 |

* Estimated annual user costs do not include existing user charges for Cave City and Horse Cave.

** Assumes 75% funding for conventional collection systems. However, conventional collection systems are generally not funded. If low pressure systems are funded at 85%, user charges are increased by approximately 5%.

# CHAPTER III

# AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES OF THE ALTERNATIVES

## PART A. INTRODUCTION

This chapter summarizes the existing natural and man-made environment of the study area, discusses the environmental impacts of the alternatives and proposed possible measures to mitigate these impacts. The purpose of the environmental setting summary is the establishment of existing baseline conditions in the area. The impacts of the various alternatives, including the No-Federal-Action alternative, are gauged against these existing conditions. The discussions of impacts and proposed mitigative measures are structured according to environmental category (i.e., odor, surface water resources, resource use, water supply, etc.). This organization is intended to facilitate the comparison of the alternatives.

## PART B. EXISTING NATURAL ENVIRONMENT

### 1. CLIMATE

The study area has a variable continental climate with wide extremes in both temperature and precipitation. Bowling Green, which lies about 30 miles southwest of Mammoth Cave, has the closest weather stations with complete records. The average annual temperature is about 59° F, with 100 year extremes of -21°F and 113°F. Precipitation is well distributed throughout the year and averages about 49 inches per year. Droughts have occurred, but they are short in duration.

The average daily wind speed for the entire year is between 6 and 7 m.p.h. The prevailing wind direction is from south to southwest. During the fall, some areas have winds with a prevailing northerly direction. Between 1950 and 1977 there have been 6 tornadoes in Barren County, 1 in Edmonson County, 8 in Warren County, and 3 in Hart County.

## 2. AIR QUALITY

Because the area is primarily rural, severe air pollution problems do not occur. The main source of air pollution is the exhaust emissions from vehicles used by local residents and tourists visiting the Mammoth Cave National Park. The occasional burning of trash and debris results in minor, short time, local pollution.

## 3. ODOR

The major odor problem in the study area is associated with the sub-surface discharge of the Horse Cave Treatment Plant. The combined activities of the Ken-Dec Metal Plating Plant, Hart County Creamery and the treatment plant have had serious impacts on Hidden River Cave system. The combination of metal laden effluent, creamery waste and ineffective treatment have produced major odor problems in the downtown Horse Cave area. The Hidden River Cave was operated as a tourist attraction from 1916 until 1944 and at times as a source of drinking water for the town. Current conditions, including odor problems, associated with the treatment plant sub-surface discharge prevent the use of this cave as a tourist attraction or water source.

Minor odor problems are associated with malfunctioning and poorly maintained on-lot treatment systems in the study area.

## 4. NOISE

Overall, the study area has relatively low ambient noise levels. Land use is primarily agricultural. Developed sections of the study area include small commercial areas and visitor facilities at Mammoth Cave National Park, along transportation routes and residential development at Park City, Cave City, Horse Cave, and Munfordville. The major noise generators are the highways and the railroad. These include:

U.S. Route 31W - the only major local route passing through Park City, Cave City, Horse Cave, and Munfordville.

Interstate 65 - major highway with high speed travel and truck traffic and clusters of commercial establishments at interchanges.

Route 70 - major access route into Mammoth Cave National Park.

Railroad Corridor - heavily used Louisville and Nashville Railroad passing through Park City, Cave City, Horse Cave and Munfordville.

## 5. TOPOGRAPHY

The study area is within the physiographic region known as the Mississippian Plateau. The topography is referred to as karst topography. The terrain is characterized by numerous sinkholes and other features, primarily vertical shafts and caves, formed by subsurface solution of limestone. An escarpment runs through the study area from the southwest corner to the northeast corner. The sinkholes are commonly found to the southeast of this escarpment. Elevations range from 450 feet above sea level along the Green River in the western portion of the study area to nearly 1000 feet above sea level in eastern Hart County.

Steep slopes (>25%) are commonly found along the banks of the Green River and the escarpment. Because of steep sloping river banks, the Green River does not have wide flood plains. Some flooding of caves occurs during periods of high flow.

## 6. GEOLOGY

### General Geology

The study area occupies a considerable portion of the area widely known as the "Central Kentucky Karst". It consists of the Pennyroyal Plateau to the south and east (which is further subdivided into the Sinkhole Plain and the Glasgow Upland), Chester Cuesta (sometimes called the Mammoth Cave Plateau), and the Western Coal Field. The Pennyroyal Plateau and the Chester Cuesta are separated by the 60-meter high Chester Escarpment (shown as the Dripping Springs Escarpment on older maps).

Figure III-1 presents a cross-section of the main features of the Central Kentucky Karst. This figure identifies various rock formations, their elevation in feet, and distance north of the Barren River in miles. It also shows the location of various physiographic features, surface and subsurface water bodies, and the location of the boundary between the Sinkhole Plain and the Glasgow Upland.

The boundaries of the Central Kentucky Karst occur along natural hydrologic divides. The northern boundary is the Green River which is a master base level stream in the area. The Southern boundary is the drainage divide between water that flows north onto the Sinkhole Plain and is part of the recharge of the carbonate aquifer there, and drainage that flows to the south into tributaries of the Barren River. The eastern boundary is also the Green River where it crosses the Sinkhole Plain just east of Munfordville. The western boundary is the Barren River which flows north across the Sinkhole Plain near Bowling Green.

CROSS-SECTION OF THE CENTRAL KENTUCKY KARST

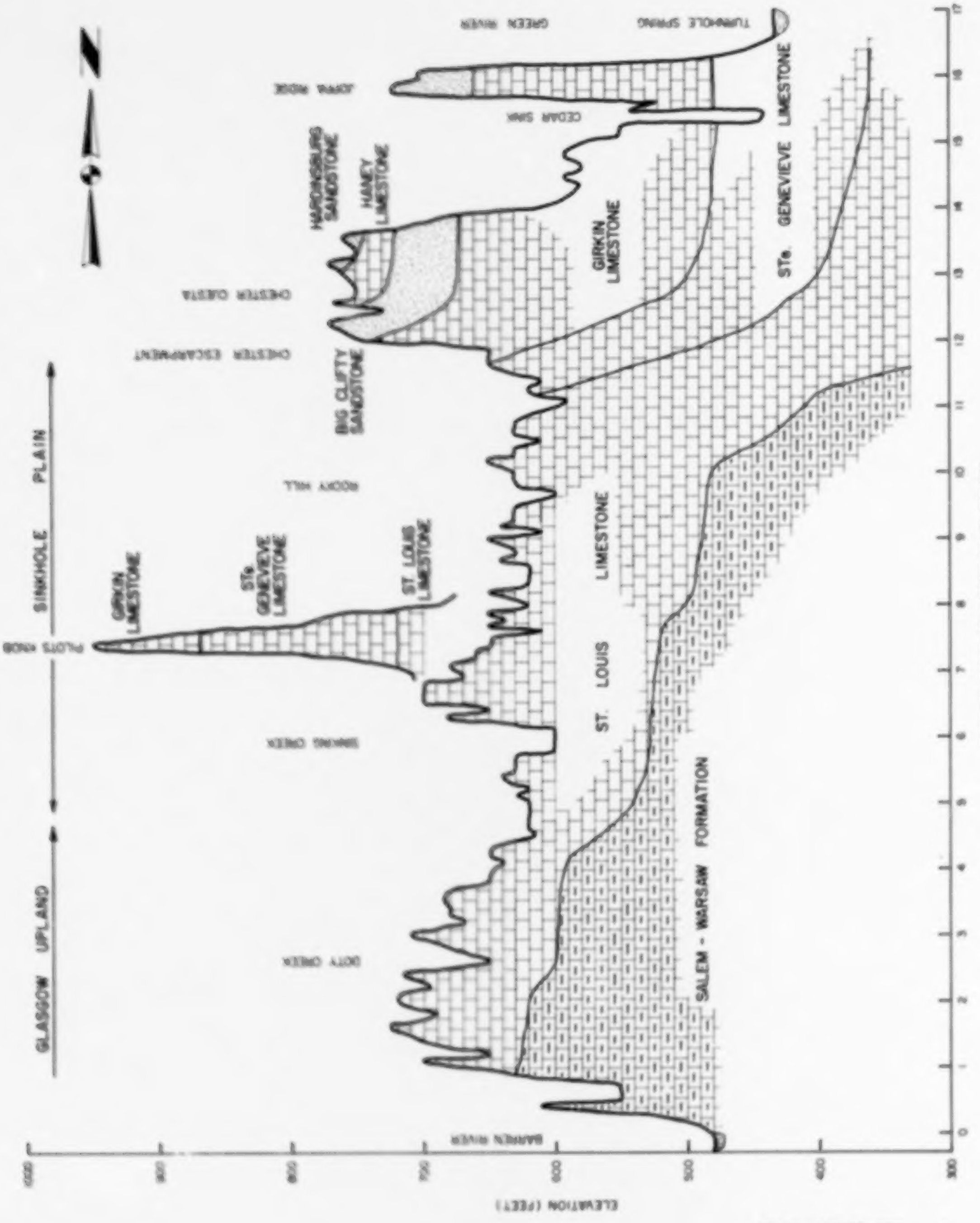

GLASGOW UPLAND
SINKHOLE PLAIN
N
BARREN RIVER
DOTY CREEK
SINKING CREEK
PILOTS KNOB
ROCKY HILL
CHESTER ESCARPMENT
CHESTER CUESTA
CEDAR SINK
JOPPA RIDGE
GREEN RIVER
TURNHOLE SPRING
GIRKIN LIMESTONE
STe. GENEVIEVE LIMESTONE
ST. LOUIS LIMESTONE
BIG CLIFTY SANDSTONE
HARDINSBURG SANDSTONE
HANEY LIMESTONE
GIRKIN LIMESTONE
STe. GENEVIEVE LIMESTONE
ST. LOUIS LIMESTONE
SALEM - WARSAW FORMATION
ELEVATION (FEET)
1000
900
800
700
600
500
400
300
DISTANCE NORTH OF BARREN RIVER (MILES)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17

FIGURE III - I

III-3-a

## Stratigraphy

The rocks that crop out in the study area are of mainly Mississippian age with only the highest formation, the Caseyville formation of Pennsylvanian age. The limestones are clearly exposed in the walls of the many caves in the area, making very detailed stratigraphic examination possible. There are three limestone units typically found in the study area. They are the Girkin, Ste. Genevieve, and St. Louis formations. They are noted on Figure III-1.

## Structure

On a very general level, the structural setting of the study area is that of a monocline with beds dipping gently to the northwest toward the Illinois Basin (or alternatively off the western flank of the Cincinnati Arch). Several small faults occur in the study area. Rocks of the area are strongly jointed, however joints and fractures appear to be less important in determining direction of groundwater flow and in controlling the orientation of cave passages than are bedding plane partings. These bedding plane partings seem to be the dominant source of secondary permeability in the Central Kentucky limestone aquifer.

## Description of Karst Formations

Two karst formations are visible in the Mammoth Cave Study Area - the karst valleys and the Sinkhole Plain. Solutional karst valleys a half mile or more in width and several miles long, with sinkhole-pitted floors, extend in a dendritic pattern from the Green River into the Chester Cuesta. These valleys once contained perennial surface streams tributary to the Green River, but now, as a result of solutional activity, large portion of these valleys have been transformed into closed depressions, or valley sinkholes, some of which contain temporary ponds with clay-plug floors. Steep-walled sinkholes occur both on the margins of karst valleys and on valley bottoms.

The Sinkhole Plain consists of a rolling topography pocked with thousands of sinkholes. There are no surface streams and little evidence for channels or distinguishable valley development. The relief within short distances on the Sinkhole Plain varies from 30 to 100 feet with individual depressions usually 10 to 30 feet deep. All overland flow is diverted into the sinkholes. The rolling topography of the Sinkhole Plain is broken by the occasional knob that rises to elevations of 200 to 300 feet above the average elevation of the Sinkhole Plain (see cross-section in Figure III-1).

The distribution of sinkholes over the Plain is quite irregular. Some of the variation is probably of structural origin related to the out-crop pattern of the chert horizons in the lower Ste. Genevieve and

St. Louis limestones. The chert serves as a local capping bed and localizes the groundwater infiltration.

Three origins have been proposed for the sinkholes: (i) solution sinks formed by the solutional removal of the limestone bedrock at some point of structural weakness such as the intersection of two joints which permits a localized infiltration of groundwater (ii) collapse sinks formed when the underlying caves collapse (iii) roots of vertical shafts left behind when the escarpment retreated.

## Description of Local Caves

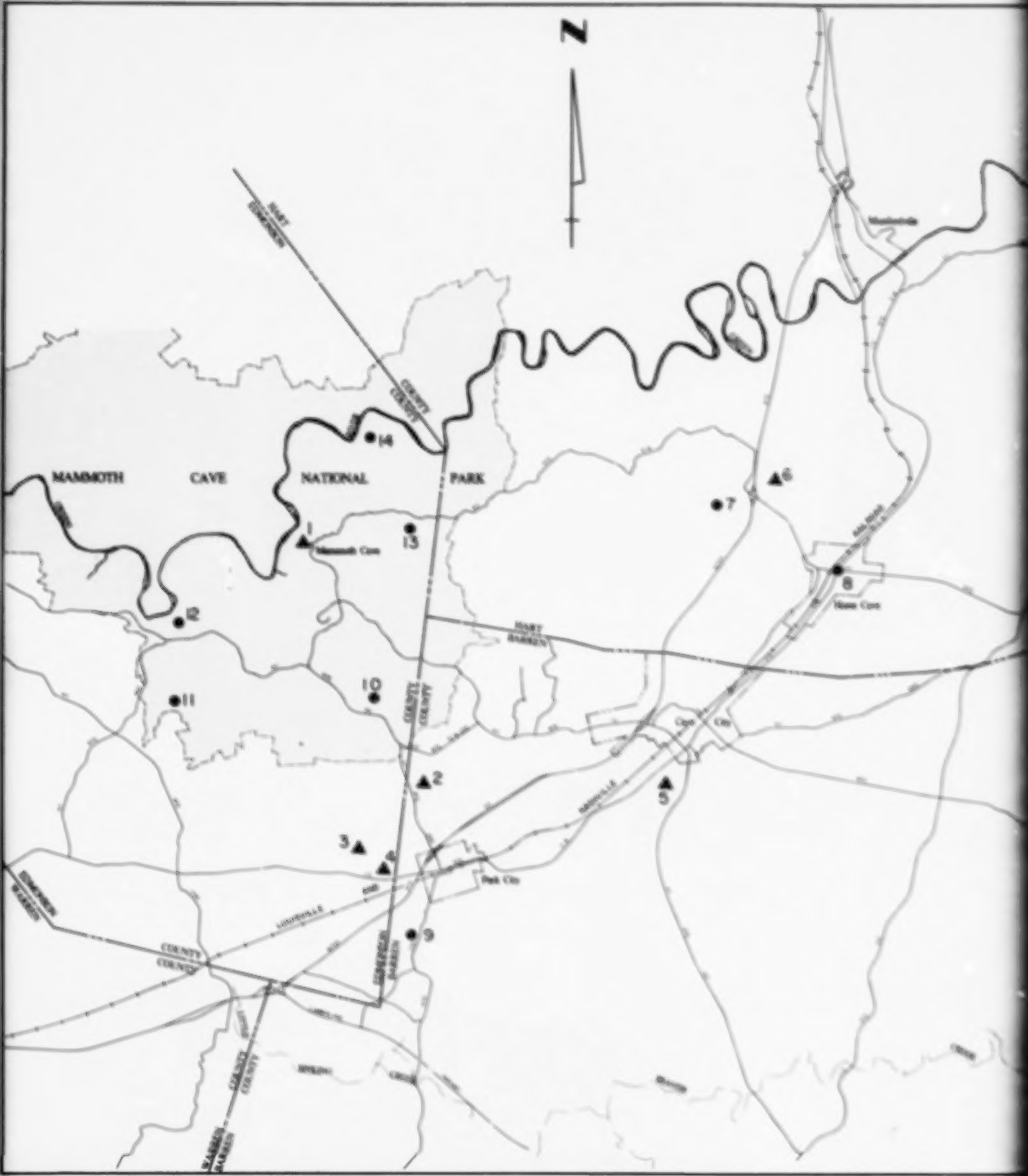
Hundreds of caves abound under the Sinkhole Plain, in the dissected margin of the Cuesta and under the main Cuesta ridges. These caves range in size from tiny fragments to the longest cave in the world - the Flint-Mammoth System. At least 11 study area caves either are presently or have, at some time in the past, been presented as show caves to the public. There are presently six private show caves open to the public. They are: Crystal Onyx Cave, Diamond Caverns, Jesse James Cave, Coach Cave, Hundred Domes Cave, and Mammoth Onyx Cave.

The caves of the Central Kentucky Karst are composed of two main components - horizontal passages and vertical shafts. These caves are generally related closely to present and past underground drainage patterns. The size of cave passages is largely dependent on the drain size. Master drains are found as cave passages of intermediate size and trunk drains are generally the largest cave passages in the region.

The ten largest caves in the study area are: The Flint Mammoth Cave System, Great Onyx Cave, Procter Cave, Lee Cave, Smith Valley Cave, Crumps Cave, James Cave, The Hidden River System, Parker Cave, and Graham Spring System. Figure III-2 shows the location of the cave systems in the Mammoth Cave Area.

## Environmental Sensitivities

The cave systems of the Central Kentucky Karst are very sensitive to intrusion of pollutants from the surface through either direct infiltration of surface water or by pollutants traveling laterally through low level stream passages. Because caves are limited in size and because the natural processes of oxidation, bacterial action and decay that serve to restore surface environments operate very slowly or not at all in a cave, the cave environment is very sensitive to intrusion of these pollutants. There are three threats to the caves: (1) Loss of scenic value due to contamination of the cave air or streams by pollutants, and subsequent threats to the tourist industry, (2) Damage to aquatic and terrestrial life forms, (3) Damage to min-


N
MAMMOTH
CAVE
NATIONAL
PARK
HART
EDMONSON
COUNTY
COUNTY
Mammoth Cave
Munfordville
Horse Cave
HART
BARREN
Cave City
Park City
EDMONSON
WARREN
EDMONSON
BARREN
WARREN
BARREN
LOUISVILLE
NASHVILLE
SPRING
CREEK
1
2
3
4
5
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12
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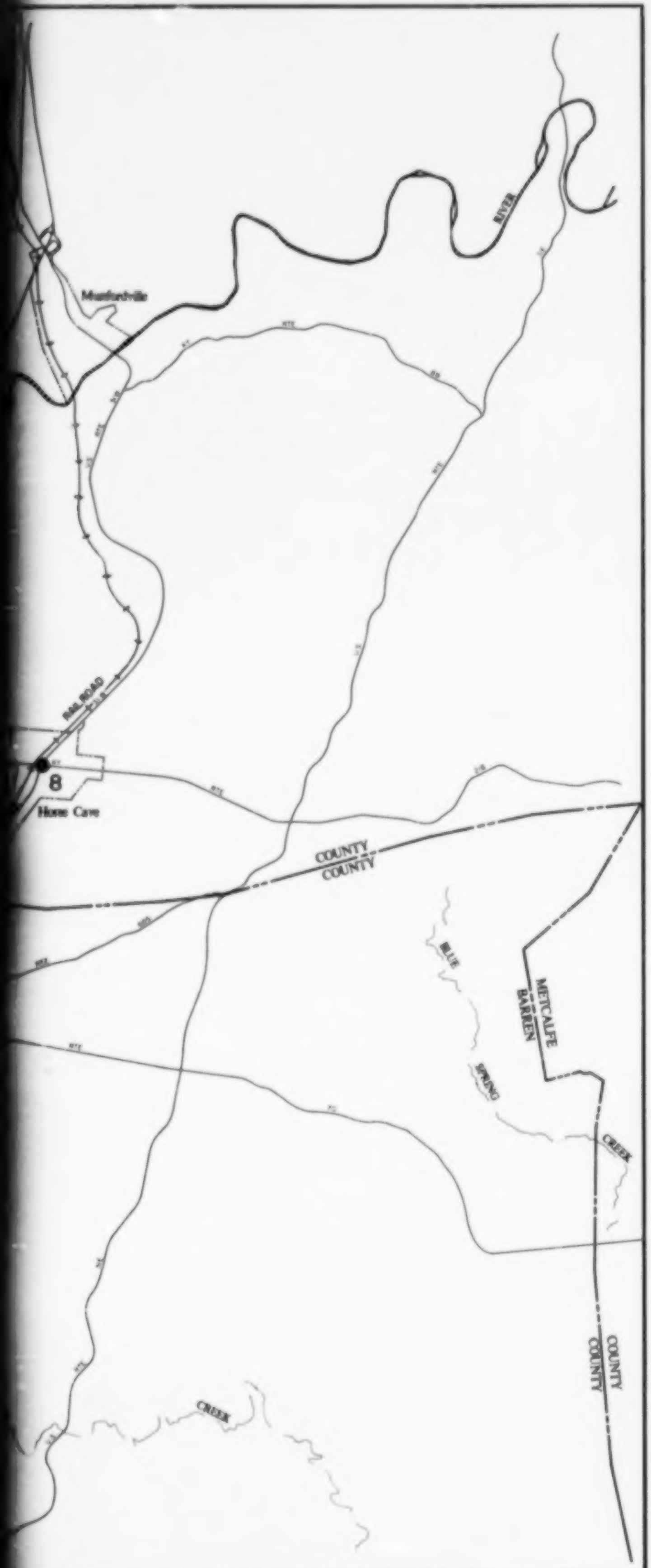
14


Munfordville
RIVER
RAILROAD
8
Horse Cave
COUNTY
COUNTY
BLUE
SPRING
CREEK
METCALFE
BARREN
CREEK
COUNTY
COUNTY

## LEGEND

▨ MAMMOTH CAVE NATIONAL PARK

▲ COMMERCIAL CAVES - OPEN TO PUBLIC
1. MAMMOTH CAVE
2. DIAMOND CAVERNS
3. HUNDRED DOMES CAVE
4. JESSE JAMES CAVE
5. CRYSTAL ONYX CAVE
6. MAMMOTH ONYX CAVE

● NON-COMMERCIAL CAVES
7. CRUMPS CAVE
8. HIDDEN RIVER CAVE
9. PARKER CAVE
10. PROCTOR CAVE
11. SMITH VALLEY CAVE
12. LEE CAVE
13. COLOSSAL CAVE
14. GREAT ONYX CAVE

FIGURE III-2

MAMMOTH CAVE AREA
201 FACILITIES PLAN

ENVIRONMENTAL IMPACT STATEMENT

## CAVE SYSTEM LOCATIONS

12,000 6000 0 12,000 24,000
Scale In Feet

U.S. Environmental Protection Agency
Region IV Atlanta, Georgia

eral deposits and other special features, some of which are stable only within a narrow range of temperature and relative humidity.

The horizontal drainage zone of caves is the most readily threatened by sewage, septic tank effluent, industrial wastes, feedlot runoff and other waste disposal. The vertical drainage zone may be threatened mainly if the sources of pollutants are located on the slopes of the slopes or ridge tops above the cave.

## 7. SOILS

There are nine soil associations in the study area. Because soil information was obtained from individual district soil conservationists, the soil associations differ slightly from one county to another. Only the soils of Barren County have been studied and described in a County Soil Survey.

Soil associations in the study area indicate that all the soils have severe limitations for on-lot disposal systems. However, soils should be examined on a more site specific basis to determine if outlying areas can be left on conventional on-lot systems or if alternate systems may be appropriate.

Soil factors that limit the use of septic tanks, spray irrigation and overland flow disposal methods in the area are listed by soil association and soil series on Table III-1.

## 8. SURFACE WATER RESOURCES

The major surface water body in the study area is the Green River. It has the largest river basin of the twelve Kentucky river basins. The Green River serves as both a wastewater receiving stream and a water supply source for the study area. Water quality of the Green River is generally considered to be good, due to a large assimilative capacity and lack of upstream development. Table III-2 presents the Kentucky Water Quality Standards and water quality data compiled by the Kentucky Division of Water Quality from 1970 to 1974. According to the data, lead and fecal coliform violations of the standards have occurred in the Green River, however, these are not considered to present a serious threat to water quality.

Other than the Green River, there are few surface streams in the study area because of the hydrologic conditions associated with the Karst geology. Surface runoff from the higher elevations flows north toward the Green River, sinks at the south and east margin of the sinkhole plain and then forms cave streams. As these streams continue to flow beneath the sinkhole plain to the Green River they are also fed by runoff into sinkholes and direct infiltration. Thus, in the study area, there are no surface tributaries to the Green River. There are, however, only three additional surface streams in the study

## TABLE III-1

## SOIL FACTORS WHICH MAY LIMIT THE USE OF SEPTIC TANKS, SPRAY IRRIGATION AND OVERLAND FLOW WITHIN SOILS ASSOCIATIONS IN THE STUDY AREA

| Soils | Septic Tanks | Spray Irrigation | Overland Flow |
|---|---|---|---|
| Baxter-Bedford association | | | |
| Baxter | slope | slope | slope |
| Bedford | slow percolation | slow percolation | slope |
| Baxter-Talbott-Dickson association | | | |
| Baxter | slope | slope | slope |
| Talbott | slow percolation | slow percolation | slope |
| Dickson | slow percolation | slow percolation | slope |
| Caneyville-Zanesville-Weikert association | | | |
| Caneyville | depth to bedrock, slow percolation, slope, rock outcrops | depth to bedrock slow percolation | depth to bedrock, slope |
| Zanesville | slow percolation, fragipan | slow percolation, depth to bedrock | depth to bedrock slope |
| Weikert | depth to bedrock, slope | depth to bedrock, slope | depth to bedrock slope |

TABLE III-1 (Con't)

### SOIL FACTORS WHICH MAY LIMIT THE USE OF SEPTIC TANKS, SPRAY IRRIGATION AND OVERLAND FLOW WITHIN SOILS ASSOCIATIONS IN THE STUDY AREA

| Soils | Septic Tanks | Spray Irrigation | Overland Flow |
|---|---|---|---|
| Cumberland-Pembroke association | | | |
| Cumberland | slope | slow percolation | slope |
| Pembroke | slope | possibly | slope |
| Dickson-Melvin-Crider association | | | |
| Dickson | slow percolation | slow percolation | slope |
| Melvin | flooding/seasonal high water table | flooding/seasonal high water table | flooding |
| Crider | slope | possibly | slope |
| Pembroke-Crider association | | | |
| Pembroke | slope | possibly | slope |
| Crider | slope | possibly | slope |
| Sadler-Johnson association | | | |
| Sadler | slow percolation | slow percolation | possibly suitable |
| Johnsburg | wet, slow percolation | wet, slow percolation | slope |

## TABLE III-1 (Con't)

## SOIL FACTORS WHICH MAY LIMIT THE USE OF SEPTIC TANKS, SPRAY IRRIGATION AND OVERLAND FLOW WITHIN SOILS ASSOCIATIONS IN THE STUDY AREA

| Soils | Septic Tanks | Spray Irrigation | Overland Flow |
|---|---|---|---|
| Weikert-Caneyville-Zanesville | | | |
| Weikert | depth to bedrock, slope | depth to bedrock, slope | depth to bedrock, slope |
| Caneyville | depth to bedrock, slope, rock outcrops | depth to bedrock, slow percolation | depth to bedrock, slope |
| Wellston | depth to bedrock | depth to bedrock | depth to bedrock, slope |
| Zanesville | slow percolation, slope | slow percolation, depth to bedrock | depth to bedrock, slope |

Sources: (See previous table)

## TABLE III-2

## WATER QUALITY DATA* FOR GREEN RIVER AT MUNFORDVILLE

| Parameter | Kentucky Water Quality Standard | No. Obs. | Mean | s | Max. | Min. | Beg. Date | End Date |
|---|---|---|---|---|---|---|---|---|
| pH<br>(Specific Units) | 6-9 | 330 | 7.7 | .4 | 9.6 | 6.8 | 1/61 | 9/73 |
| Conductivity<br>(micromhos) | 800 | 364 | 400 | 240 | 1,750 | 47 | 1/73 | 9/73 |
| Dissolved Solids<br>(mg/1) | | 335 | 220 | 130 | 1,040 | 61 | 1/61 | 9/73 |
| Alkalinity<br>(mg/1) | no standard | 210 | 96 | 25 | 153 | 40 | 10/59 | 9/73 |
| Hardness<br>(mg/1) | no standard | 327 | 130 | 50 | 387 | 45 | 1/61 | 9/73 |
| Color<br>(Platinum-Cobalt Units) | 75 | 250 | 9 | 9.6 | 55 | 0 | 10/59 | 10/72 |
| Sodium<br>(mg/1) | no standard | 66 | 43 | 41 | 218 | 3.5 | 1/61 | 10/73 |
| Potassium<br>(mg/1) | no standard | 20 | 2.2 | 1.0 | 5.2 | 0.8 | 11/59 | 10/72 |
| Chloride<br>(mg/1) | 250(EPA Proposed) | 355 | 54 | 64 | 455 | 3.0 | 1/61 | 9/73 |
| Sulfate<br>(mg/1) | 250 (EPA Proposed) | 328 | 18 | 7.0 | 106 | 7.4 | 1/61 | 9/73 |

# TABLE III-2 (Cont'd)

## WATER QUALITY DATA*FOR GREEN RIVER AT MUNFORDVILLE

| Parameter | Kentucky Water Quality Standard | No. Obs. | Mean | s | Max. | Min. | Beg Date | End Date |
|---|---|---|---|---|---|---|---|---|
| Nitrate (N-mg/1) | 10(EPA Proposed) | 35 | 0.9 | 0.3 | 1.6 | 0.4 | 3/72 | 9/73 |
| Flouride (mg/1) | 1.0 | 49 | 0.4 | 0.3 | 0.9 | 0.07 | 1/70 | 11/74 |
| Calcium | no standard | 142 | 55 | 40 | 356 | 15 | 10/59 | 10/72 |
| Magnesium (mg/1) | no standard | 142 | 11.7 | 10 | 80 | 2.5 | 10/59 | 10/72 |
| Cadmium (mg/1) | 0.1 | 59 | .019 | 0.07 | 0.05 | 0 | 1/70 | 11/74 |
| Iron (mg/1) | 0.3 | 14 | 0.05 | 0.085 | 0.33 | 0 | 10/65 | 9/66 |
| Chromium (mg/1) | 0.05 | 50 | 0.0012 | 0.0012 | 0.005 | 0 | 1/70 | 11/74 |
| Lead (mg/1) | 0.05 | 51 | 0.053 | 0.122 | 0.770 | 0.001 | 1/70 | 11/74 |
| Silver (mg/1) | 0.05 | 51 | 0.00073 | 0.0007 | 0.003 | 0 | 1/70 | 11/74 |
| Arsenic (mg/1) | 0.05 | 11 | 0.0045 | 0.0005 | 0.001 | 0 | 1/71 | 4/74 |

## TABLE III- 2(Cont'd)

## WATER QUALITY DATA*FOR GREEN RIVER AT MUNFORDVILLE

| Parameter | Kentucky Water Quality Standard | No. Obs. | Mean | s | Max. | Min. | Beg. Date | End Date |
|---|---|---|---|---|---|---|---|---|
| Dissolved Oxygen (mg/l) | 5.0 |  | No | DATA |  |  |  |  |

*Extracted From the Kentucky Water Quality Report to Congress prepared by the Kentucky Department for National Resources and Environmental Protection, Division of Water Quality.

area that have been mapped. They are Beaver Creek, Little Sinking Creek and Spring Creek. Beaver Creek is tributary to the Barren River; Spring Creek is the major tributary to the East Branch of the Hidden River Cave System; and Little Sinking Creek is a major surface tributary to a cave system that is part of the subsurface drainage to Mill Hole.

## 9. SUBSURFACE WATER RESOURCES

### Hydrogeology

The Green River is the hydrological base level for the region and receives most groundwater discharge from the study area. There are five major sources for the water that discharges to the Green River. They are: (1) The sinking streams that contribute water from the southern edge of the Sinkhole Plain (2) Direct infiltration (sometimes called internal runoff) through sinkholes on the Sinkhole Plain (3) precipitation that falls on the clastic cap rock-protected ridges recharges the perched Haney Limestone and Big Clifty sandstone aquifers which then re-emerges to enter the main limestone aquifer (4) direct infiltration through sinkholes in the karst valleys that dissect the plateau and (5) water from Green River that back-floods into the base level aquifer.

No surface runoff reaches the river. All water collected on each catchment area (except baselevel backflooding) either returns to the atmosphere through evapotranspiration or enters the underground system through either infiltration or through sinking streams or internal runoff. The surface drainage basins, the large sinkholes, and the karst valleys all serve to concentrate the water as runoff before it enters the groundwater system. The water then enters the ground at a very localized swallow point.

These inputs together form the conduit system that feeds ultimately to the springs. Each spring, therefore, can be regarded as an outlet point for an underground drainage system of some degree of complexity. The regional springs are fed by large conduits carrying water from collector systems of surface basins and sinkhole areas many miles away. Closer to the river, valley drains from the karst valleys feed into the main system and shaft drain systems feed into the valley drains. Some valley drains lead to the river directly as springs of intermediate size, while shaft drain systems for small re-entrant valleys near the river may also drain directly to the river through small springs and seeps. Thus there is a large number of springs of diverse flow characteristics.

## Non-Carbonate Aquifers

The geology and topography of the Chester Cuesta combine to create conditions for the formation of several perched aquifers above the basal water table. These zones are: (1) a generally continuous groundwater body in the Haney limestone perched on shale layers in the lower part of the Haney; (2) a generally continuous body of groundwater in the Big Clifty sandstone perched on shale at the base of the Big Clifty, and (3) discontinuous bodies of perched water above local shale beds near the top of the Girkin formation.

Perched groundwater in the Hardinsburg sandstone and the Big Clifty sandstone in the western portion of the study area can be tapped by shallow wells to produce sufficient water for domestic supplies. Here, the Cuesta is less dissected and the sandstone caprock more continuous.

The Haney limestone aquifer in the Flint Ridge is about 35 feet thick. Eight known springs occur on the Haney aquifer here, and are used as the water supply for the Mammoth Cave National Park. The base flow of these springs is 0.16 cfs. The specific base flow runoff through the springs is 0.04 cfs/mi , only 26% of the specific base flow runoff for the Karst Area as a whole, 0.15 cfs/mi . This indicates that most of the water is discharged as small seeps or is leaked downward into the underlying perched Big Clifty sandstone aquifer.

## Underground Streams

The underground drainage in the karst follows well-defined flow paths which could be considered underground streams. These underground drainage systems take many forms. Beneath the Chester Cuesta, deep flow paths occur mostly as pipe flow in flooded conditions. Valley drains and shaft drains at higher levels in the cave systems under the ridges appear as free surface streams flowing on rocky or silt-floored passages. Cave streams on the Sinkhole Plain are often perched on impermeable chert horizons and appear as free-flowing streams in large cave conduits. The Hidden River System is an example of a distributary system where a single trunk flow is broken into a number of distributary channels.

## Springs

The outlet points for the water collected in the karst aquifer are a series of springs along the Green and Barren Rivers. There are 81 springs on the Green River between Munfordville and Brownsville.

These springs are of two types: Alluviated springs and gravity springs. The alluviated springs are the most common and are developed below river level and have rise pools that are fed at depth. Pike and

Turnhole Springs are two alluviated springs which are fed from large conduits about 30 feet below pool stage of the river. Springs with unconfined outlets and free-flowing streams are gravity-type springs.

## Subsurface Drainage Areas

The principal aquifer in the study area is the St. Louis and Ste. Genevieve limestone. Evidence shows deep groundwater troughs that parallel the underground drainage lines and groundwater divides between adjacent groundwater sub-basins. An extensive dye tracing investigation produced a drainage map for the area, and determined that three major basins - the Graham Spring Basin, the Turnhole Spring Basin, and the Hidden River Sub-Basin of the Bear Wallow Basin - are of the most relevance to this study. Several conclusions were drawn from the dye tracing experiments, from water balance calculations, and from the chemical behavior of the groundwater. Briefly, they are:

1. Most of the groundwater in the Mississippian limestone aquifer is moving in well-defined systems of conduits as integrated underground streams.
2. The conduits are aggregated into well-defined underground basins.
3. Only the Turnhole Spring Basin has its discharge at a single discrete spring. All others have distributary systems in the downstream sections of the trunk so that water from the underground basins appears at more than one spring.
4. Some point source pollutants appear to drain into more than one sub-basin.
5. Sub-basin boundaries are not fixed. They move in unknown ways depending on groundwater levels in the aquifer and on the flood stage of the surface rivers.

Subsurface drainage areas are further defined in the figure, Groundwater Basins in the Mammoth Cave Region, Kentucky, contained in the map sleeve of this report.

## Groundwater Quality Standards

Presently, the Commonwealth of Kentucky does not have specific groundwater quality criteria. Existing groundwater standards are based on maintaining a quality of groundwater consistent with its designated use. In addition, an anti-degradation policy provides for the protection of groundwater which would "be significantly degraded in quality" before exceeding standards for designated use. However, for free-flowing groundwaters which have a demonstrable nexus to surface streams, the standards are more specific. The Kentucky Division of Water Quality and EPA apply Kentucky Water Quality Standards, as established in 40 CFR 120.21, which provide in Section 1.(2) of the Regulation WP-6-2[*], that these waters be classified Aquatic Life and shall meet the water quality criteria supporting that classification and, in addition, shall meet the criteria necessary to support contact recreation.

More than 90% of the groundwater discharge in the Mississipian limestone aquifer in the study area is free-flowing and moves in well defined systems of conduits as integrated underground streams (as described in the previous section). These conduits are aggregated into discrete subsurface drainage basins, each basin having a system of tributaries (from sinkholes or sinking streams) which join together forming master trunk streams which carry water towards the rivers. Since these systems have a demonstrable hydrologic nexus to the surface waters (Green River), the Aquatic Life classification may presently be applied to all these subsurface waters.

## Existing Water Quality Data

The most extensive data on groundwater in the study area are contained in published reports by James F. Quinlan and Donald R. Rowe, Ph.D., Hydrology and Water Quality in the Central Kentucky Karst Phase II Part A. These reports provide detailed information on the drainage patterns of the subsurface streams in the study area as well as estimates of discharge volumes during "base flow" conditions. In addition, Phase I includes results from intensive water quality sampling (during both moderate and base flow conditions) in the following groundwater basins: Hidden River, Grady Springs, Three Springs, Garvin Beaver, and Lawler - Blue Hole.

One of the primary functions of the Quinlan-Rowe sampling program was to trace the extent of heavy metals pollution in the Hidden River basin due to the effluent discharge from the Horse Cave wastewater treatment plant and to compare effluent-bearing springs along the Green River with springs from adjacent groundwater basins. The results of these chemical analyses and the comparisons appear in Tables III-3 and III-4 respectively.

These data indicate that the Hidden River Cave South Branch is heavily polluted with respect to toxic heavy metals due to the effluent discharge of the Horse Cave wastewater treatment facility and that the East Branch of Hidden River Cave is relatively unpolluted with heavy metals. In addition, results from analyses of the Hidden

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[*] Section 1.(2) Regulation WP-6-2: All Waters as defined in 40 CFR 125.1 not shown on the map described in (1) of this section shall be classified Aquatic Life as set forth in (Section 6 of 401 KAR 5:025) and shall meet the water quality criteria supporting that classification, and in addition shall meet the following criteria necessary to support secondary contact recreation as being: Fecal coliform shall not exceed an average of 2000/100 ml and not exceed a maximum of 4000/100 ml.

TABLE III 3 - COMPARISON OF MEANS OF CHEMICAL ANALYSES OF EFFLUENT-BEARING SPRINGS WITH THOSE OF OTHER RELEVANT SITES

| SAMPLE SITE | | GROUNDWATER BASINS | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | HIDDEN RIVER | | | | OTHER | | | | | | |
| | Mean analysis of effluent-bearing springs in the Hidden River Groundwater Basin, along the South Bank of Green River (ES) | Hidden River Cave, East Branch | Hidden River Cave, South Branch | Hidden River Cave South Br. & East. Br. | Horse Cave Wastewater Treatment Plant, Eff | Grady Spring | Three Springs | Garvin-Beaver | Lawler Blue Hole | Mean of Grady + Garvin - Beaver + Lawler | Green River | Shallow Water Wells |
| | | (HRC-E) | (HRC-S) | (HRC-S, HRC-E) | (STP-E) | (GS) | (3S) | (GB) | (L) | (3B) | (GR) | (W) |
| | | | | | RATIOS | (Rounded off, for clarity) | | | | | | |
| CHEMICAL PROPERTY | | ES / HRC-E | STP-E / HRC-E | HRC-S / HRC-E | STP-E / ES | ES / GS | ES / 3S | ES / GB | ES / L | ES / 3B | ES / GR | ES / W |
| Chromium | .005 mg/1 | 1.8 | 1.3 | 940 | 670 | 4.0 | 3.3 | 4.0 | 5.8 | 4.6 | 6.5 | 3.7 |
| Nickel | .018 mg/1 | 2.6 | 2.2 | 590 | 512 | 4.5 | 5.8 | 4.9 | 6.0 | 5.1 | 4.2 | 9.0 |
| Copper | .005 mg/1 | 1.2 | 3.9 | 140 | 450 | 2.1 | 1.8 | 2.6 | 2.4 | 2.4 | 2.4 | .3 |
| Zinc | .009 mg/1 | 1.0 | .78<br>2.7 | 98 | 77<br>(209)* | 1.6 | 1.6 | 3.0 | 1.8 | 2.1 | 1.4 | --- |
| Chloride | 11.6 mg/1 | 1.2 | 3.1 | 2.6 | 7.1 | 2.2 | 1.1 | 2.0 | 2.1 | 2.1 | 1.3 | 3.0 |
| Sodium | 5.8 mg/1 | 1.2 | 3.0 | 11.4 | 29 | 3.4 | .2 | 2.3 | 3.5 | 2.9 | 1.4 | 3.5 |
| Potassium | 1.3 mg/1 | 1.1 | 2.8 | 11.5 | 29 | 1.2 | .9 | 1.3 | 1.2 | 1.3 | 1.1 | 1.9 |
| Carbonate Hardness | 206 mg/1 | 1.0 | Mean of all but zinc ratios is 2.7. This mean is assumed for zinc. | .9 | .8 | 1.0 | 1.0 | 1.1 | 1.4 | --- | 2.0 | 1.0 |
| Ca/Mg Ratio | 4.63 | 1.0 | | 1.4 | 1.4 | .9 | 1.1 | .7 | .7 | --- | 1.3 | 3.0 |
| Specific Conductance | 420 umhos/cm | 1.0 | | 1.2 | 2.8 | 1.1 | .8 | 1.1 | 1.4 | --- | 1.7 | 1.0 |

*Calculated from assumed STP-E/HRC-S ratio of column 4.

Source: Quinlan, James and Donald R. Rowe, Hydrology and Water Quality in the Central Kentucky Karst Phase I.

TABLE III 4 - SUMMARY OF CHEMICAL ANALYSES
(MEAN, MAXIMUM AND MINIMUM) AT RELEVANT SITES

SUMMARY OF CHEMICAL ANALYSES:
GROUNDWATER BASINS

MEAN
MAXIMUM
MINIMUM

| SAMPLE SITES / CHEMICAL PROPERTY & LIMITS** | | HIDDEN RIVER | | | | OTHER | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Effluent-Bearing Springs | Hidden River Cave East Branch | Hidden River Cave South Branch | Horse Cave Wastewater Treatment Plant, Eff. | Grady Spring | Three Springs | Garvin-Beaver | Lawler Blue Hole | Grady + Garvin-Beaver + Lawler B.H. | GREEN RIVER | HIDDEN RIVER BASIN SHALLOW WATER WELLS | HORSE CAVE WASTEWATER TREATMENT PLANT, INFLUENT |
| Chromium 5.0 (.05) | mg/l (heavy metal values rounded off to nearest .001) | .015<br>.005<br>.001 | .008<br>.003<br>.002 | 8.90<br>2.73<br>.202 | 6.75<br>3.48<br>.010 | .002<br>.001<br>.001 | .003<br>.002<br>.001 | .002<br>.001<br><.001 | .002<br>.001<br><.001 | .002<br>.001<br><.001 | .002<br>.001<br><.001 | .003<br>.001<br><.001 | 21.7<br>7.33<br>.150 |
| Nickel 5.0 | | .057<br>.018<br>.008 | .013<br>.007<br>.001 | 19.6<br>4.13<br>1.15 | 12.2<br>9.22<br>6.21 | .007<br>.004<br>.002 | .005<br>.003<br><.001 | .005<br>.004<br>.003 | .006<br>.003<br>.003 | .007<br>.004<br>.001 | .025<br>.006<br><.001 | .004<br>.002<br><.001 | 27.2<br>12.0<br>.198 |
| Copper .02 (1.0) | | .011<br>.005<br>.003 | .007<br>.004<br>.002 | 1.17<br>.564<br>1.30 | 4.72<br>2.28<br>2.95 | .005<br>.002<br>.001 | .006<br>.003<br>.002 | .002<br>.002<br>.002 | .004<br>.002<br>.001 | .006<br>.002<br>.001 | .003<br>.002<br>.001 | .021<br>.007<br>.003 | 5.36<br>1.64<br>.080 |
| Zinc .3 (5.0) | | .320<br>.080<br>.191 | .021<br>.009<br>.004 | 2.12<br>.041<br>.074 | .952<br>.052<br>.396 | .006<br>.005<br>.003 | .012<br>.005<br>.027 | .003<br>.003<br>.003 | .011<br>.005<br>.002 | .012<br>.006<br>.002 | .012<br>.006<br>.002 | not analyzed | 11.9<br>2.21<br>.220 |
| Chloride | | 26.0<br>11.6<br>3.6 | 15.0<br>10.0<br>5.6 | 40<br>26.2<br>11 | 110<br>82<br>35 | 8.2<br>5.2<br>4.0 | 128<br>50<br>13 | 13<br>5.0<br>3.2 | 7.6<br>5.6<br>2.9 | 13<br>5.6<br>2.9 | 13<br>9.2<br>6.1 | 5.6<br>3.8<br>2.5 | 218<br>94<br>35 |
| Sodium | | 15.0<br>5.79<br>1.30 | 9.00<br>4.01<br>2.70 | 197<br>54.6<br>20.0 | 480<br>165<br>70.0 | 2.00<br>1.71<br>1.22 | 76<br>29.0<br>4.6 | 6.30<br>2.57<br>1.50 | 2.65<br>1.65<br>1.00 | 6.36<br>2.0<br>1.00 | 7.5<br>3.80<br>2.4 | 3.25<br>1.68<br>.82 | 213<br>148<br>61 |
| Potassium | | 2.18<br>1.27<br>.92 | 1.76<br>1.13<br>.60 | 56.0<br>13.2<br>2.05 | 116<br>61.1<br>6.65 | 1.61<br>1.07<br>.67 | 2.16<br>1.43<br>1.07 | 1.03<br>0.97<br>0.18 | 1.01<br>1.08<br>.60 | 1.63<br>1.0<br>.18 | 1.71<br>1.13<br>.70 | 1.27<br>.66<br>.39 | 88.0<br>32.1<br>10.6 |
| Carbonate Hardness | | 463<br>206<br>121 | 255<br>214<br>188 | 280<br>200<br>170 | 200<br>163<br>118 | 226<br>200<br>150 | 325<br>213<br>167 | 248<br>188<br>166 | 183<br>151<br>129 | ——— | 132<br>103<br>73 | 265<br>212<br>185 | 279<br>197<br>130 |
| Ca/Mg Ratio | | 5.06<br>4.63<br>3.10 | 5.49<br>4.60<br>4.23 | 8.13<br>6.36<br>3.06 | 11.17<br>6.31<br>.93 | 6.30<br>5.09<br>4.12 | 5.06<br>6.10<br>3.15 | 9.21<br>6.28<br>3.46 | 8.77<br>6.30<br>4.61 | ——— | 5.06<br>3.71<br>2.78 | 3.08<br>1.36<br>.06 | 10.48<br>7.49<br>4.25 |
| Specific Conductance umhos/cm | | 540*<br>420<br>217 | 520<br>422<br>379 | 670<br>522<br>299 | 1350<br>1170<br>960 | 650<br>395<br>330 | 865<br>563<br>330 | 620<br>381<br>328 | 355<br>303<br>252 | ——— | 300<br>250<br>173 | 690<br>426<br>360 | [illegible]<br>2430<br>715 |
| No. of Sample Sites | | 13 | 1 | 1 | 1 | 1 | 3 | 2 | 1 | 7 | 2 | 16 | 1 |
| Average Total No. of Samples | | 30 | 6 | 8 | 10 | 5 | 17 | 11 | 7 | 23 | 18 | 17 | 13 |

* This maximum for specific conductance does not include the 941 value caused by local seepage of brine into a single spring (Rich).
** The first figure in column 1 is the concentration fatal to some fish (Gherumlatoff et al. 1976). The figure in parentheses is the maximum allowed by State and/or Federal standards for public water supplies.
Source: Quinlan, James and Donald R. Rowe, Hydrology and Water Quality in the Central Kentucky Karst Phase I.

River effluent-bearing springs indicate that, even under base flow conditions, sufficient dilution is available in the Hidden River system to reduce concentrations of heavy metals at the springs to within drinking water standards. However, as mentioned in the report, drinking water standards may not protect some forms of aquatic life. Furthermore, different heavy metals concentrations in the effluent bearing springs ranged from 1.9 (zinc) to 5.1 (nickel) times greater than springs in adjacent groundwater basins. These adjacent basins, Grady Spring, Three Springs, Garvin-Beaver and Lawler Blue Hole are considered to be representative of unpolluted (with respect to heavy metals), free-flowing groundwaters in the area.

The data provided by Quinlan-Rowe is considered to be of only limited use in assessing the applicability of the Aquatic Life classification to all subsurface waters in the area of developing groundwater standards for two reasons:

1. Limited sampling sites
2. With the exception of some bacteriological tests, water quality analyses were only performed for heavy metals and other inorganic parameters. Evidences of pollution resulting from human or animal waste are not usually detected with analyses for these parameters.

## Field Sampling Program

A field sampling program was conducted by GFC&C, Inc. as part of this environmental impact statement to expand on the Quinlan-Rowe data base and to provide the following types of information:

- Natural water quality of subsurface streams and of sinking streams that flow into the groundwater system.
- Water quality of subsurface streams receiving wastewater discharges.
- Identification of sources of groundwater pollution.

The field sampling program included analyses for heavy metals, other inorganic parameters, and for water quality parameters specifically associated with human and animal wastes as well as agricultural activities. Parameters sampled were:

- Dissolved Oxygen
- Biochemical Oxygen Demand (BOD)
- Nitrogen

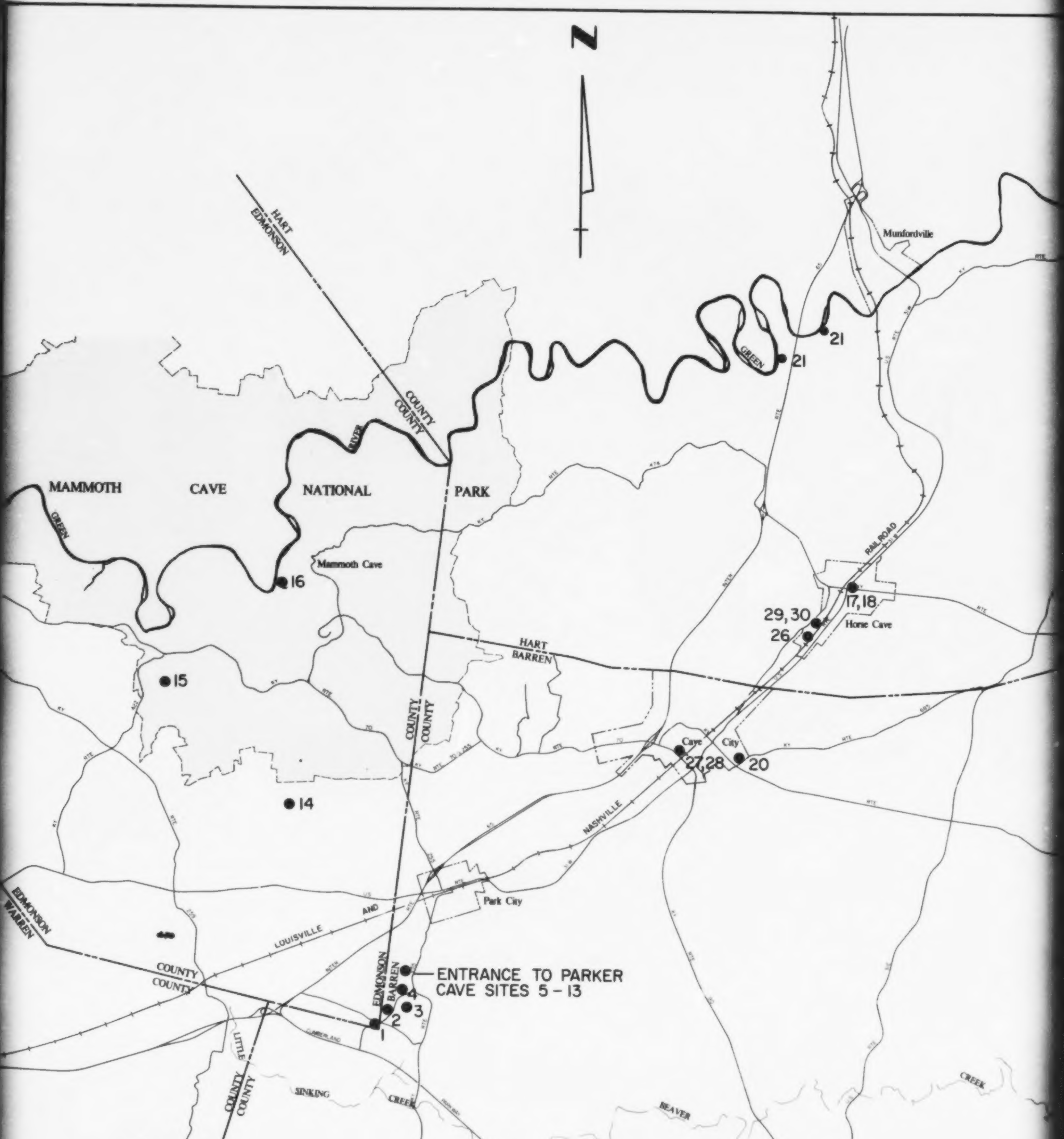
- Total Coliform, Fecal Coliform, Fecal Streptococci and FC/FS Ratio
- Heavy Metals
- Conductivity
- pH
- Hardness
- Solids (Total Dissolved and Total Suspended)
- Chlorides and Sulfates
- Phosphorus and Phosphates
- Methylene Blue Active Substances (MBAS)

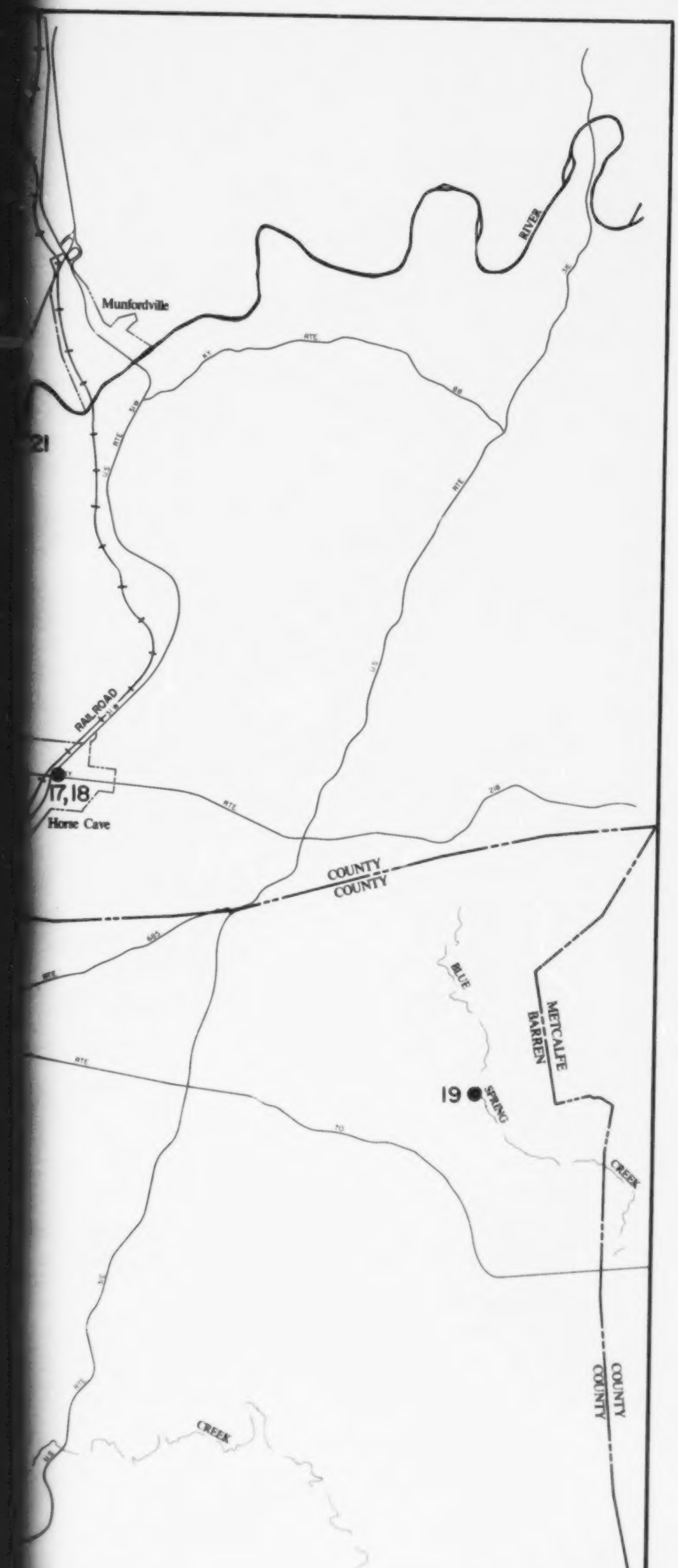
The sampling program was conducted in two phases, the first phase during moderate flow conditions (March 1978) and the second during base flow conditions (September-November 1978). During both moderate and base flow conditions one-time grab samples were collected at each sampling location. However, since base flow conditions are generally much more critical for maintaining water quality an extended sampling program was conducted to expand the limited data generated by a one-time grab sample. Samples were collected each week (for a period of 10 weeks) at seven strategic sampling sites. These sites were selected after consultation with the Groundwater Technical Advisory Committee associated with this study. During this sampling program analyses were performed for the following parameters:

1. Dissolved Oxygen (1/week)
2. Nitrate, Ammonia and Total Kjeldahl Nitrogen (1/2 weeks)
3. Conductivity (1/week)
4. Temperature (1/week)
5. Heavy Metals (Hidden River Basin sites only) (1/week)

## Sampling Sites

The twenty-six sampling stations selected for the program are indicated on Figure III-3. Sampling stations 1-15 are located at various points in the Turnhole Spring basin from the headwaters area to Cedar Sink. Sites 5-13 are located in Parker Cave. Sampling station 16 is situated at the Echo River Spring of the Echo-Styx Basin. Sampling stations 17-21 are located at different points in the Hidden River Basin, while stations 26-30 are found at the major wastewater


N
HART
EDMONSON
COUNTY
COUNTY
MAMMOTH
CAVE
NATIONAL
PARK
GREEN
RIVER
Mammoth Cave
16
15
14
Munfordville
21
21
RAILROAD
17,18
29,30
26
Horse Cave
HART
BARREN
COUNTY
COUNTY
Cave
City
27,28
20
NASHVILLE
AND
LOUISVILLE
Park City
EDMONSON
WARREN
COUNTY
COUNTY
EDMONSON
BARREN
ENTRANCE TO PARKER
CAVE SITES 5 - 13
4
3
2
1
CUMBERLAND
LITTLE
SINKING
CREEK
BEAVER
CREEK
COUNTY
COUNTY
WARREN
BARREN


RIVER
Munfordville
21
RAILROAD
17,18
Horse Cave
COUNTY
COUNTY
BLUE
SPRING
19
METCALFE
BARREN
CREEK
COUNTY
COUNTY
CREEK

## LEGEND

▨ MAMMOTH CAVE NATIONAL PARK

● SAMPLING SITE LOCATION

1. GLASGOW UPLAND
2. GUILFOIL SPRING
3. LOCAL HOGLOT DRAINAGE
4. APPLE - GROVE GUILFOIL SPRING STREAM *

5-13. PARKER CAVE STATIONS

14. MILL HOLE *
15. CEDAR SINK (MAR. SAMPLE) OWL CAVE (OCT. SAMPLE)
16. ECHO RIVER
17. SOUTH BRANCH HIDDEN RIVER *
18. EAST BRANCH HIDDEN RIVER *
19. BLUE SPRING BRANCH *
20. L & N CAVE *
21. HICK'S SPRING (MAR. SAMPLE) GORIN MILLS (OCT. SAMPLE)
26. KEN - DEC MANHOLE
27. INF. CAVE CITY STP
28. EFF. CAVE CITY STP
29. INF. HORSE CAVE STP
30. EFF. HORSE CAVE STP *

* LONG - TERM SAMPLING SITE.

FIGURE III - 3

MAMMOTH CAVE AREA
201 FACILITIES PLAN

ENVIRONMENTAL IMPACT STATEMENT

## SAMPLING SITE LOCATIONS

12,000 6000 0 12,000 24,000
Scale In Feet

U.S. Environmental Protection Agency
Region IV Atlanta, Georgia

sources in the Hidden River Basin (Ken Dec, Inc., Horse Cave wastewater treatment plant and Cave City wastewater treatment plant).

Two objectives which dictated the water quality sampling sites for this study were:

- To monitor water quality in a "typical" drainage basin as water flows from headwaters, to surface streams, to subsurface drainage under the sinkhole plain and then into the Green River.
- To monitor water quality data upstream and downstream of the known subsurface wastewater discharges of Horse Cave and Cave City and to monitor the effluents at each plant.

## Results and Discussion

Based on the water quality analyses results from both moderate and base flow sampling, it appears that, with the exception of the polluted waters in the Hidden River Cave System, the water quality of the sinking streams and subsurface waters in the study area is generally good to excellent, sufficient for maintaining aquatic life. The aquatic life water quality criteria are defined by the EPA Quality Criteria for Water, EPA, Washington, D.C., July 1976. EPA criteria for selected water quality parameters for the use classifications of aquatic life, bathing water and public water supply are presented in Table III-5.

The following is a discussion of the field sampling results, dealing first with results of the one-time grab samples during moderate and base flow conditions, and then with results of the base flow extended program.

## One-Time Grab Samples

Table III-6 presents the findings of the one-time grab samples program based on field observations and water quality analyses. The following discussion of the results of the one-time grab samples for each Basin, includes only the results of analyses considered critical in assessing water quality or those which violated the water quality criteria defined by EPA (Table III-5).

## TABLE III-5
## EPA CRITERIA FOR SELECTED WATER QUALITY PARAMETERS FOR USE CLASSIFICATIONS OF AQUATIC LIFE, DRINKING WATER AND SECONDARY CONTACT

| Parameter | Use Classification | | |
|---|---|---|---|
| | Aquatic Life | Raw Drinking Water | Secondary Contact |
| Ammonia | .02 mg/1 (as un-ionized ammonia) | - | - |
| Chromium | .1 mg/1 | .05 mg/1 | - |
| Fecal Coliform | - | - | 200/100 ml (log mean) |
| Chlorides | | 250 mg/1 | - |
| Copper | .1 times 96-hr LC 50 for resident species | 1 mg/1 | - |
| Iron | 1.0 mg/1 | .3 mg/1 | - |
| Lead | .01 times 96-hr LC 50 for resident species | .05 mg/1 | - |
| Nickel | .01 times 96-hr LC 50 for resident species | - | - |
| Nitrates | - | 10 mg/1 ($NO_3$-N) | - |
| Dissolved Oxygen | $\geq$5 mg/1 | - | - |
| pH | 6.5 - 9.0 | 5-9 | - |
| Total Dissolved Solids | - | 250 mg/1 for chlorides and sulfates | - |
| Sulfates | - | 250 mg/1 | - |
| Sulfides | 2 mg/1 undissociated $H_2S$ | - | - |
| Zinc | .01 times 96-hr LC 50 for resident species | 5 mg/1 | - |

TABLE III-6 SUMMARY NOTES* ON RESULTS OF GRAB SAMPLES AT EACH SAMPLING SITE DURING MODERATE AND LOW FLOW SAMPLING CONDITIONS

| SAMPLE STATION | DESCRIPTION | MODERATE FLOW COMMENT | BASE FLOW COMMENT |
|---|---|---|---|
| 1 | Glasgow Uplands (Apple Grove Headwaters) | Total Kjeldahl Nitrogen of 1.1 mg/l is highest of non-polluted waters. May be due to organic decay in the bog area. Meets drinking water and aquatic life water quality criteria. | There was no water at the original sampling site under base flow conditions. The site was moved to a point several yards upstream from site #2. At this station flow was nearly zero. Fecal coliform MPN about 1000/100 ml. Conductivity 65 µmhos. Fecal coliform most likely due to animal wastes since sample was taken in pastureland runoff. Meets drinking water and aquatic life water quality criteria. |
| 2 | Guilfoil Spring (Downstream from water supply spring confluence with Apple Grove Stream) | No unusual characteristics water quality good to excellent. Meets drinking water and aquatic life water quality criteria. | Base flow approximately .04 cfs. Fecal coliform MPN diluted to approximately 200/100 ml. Highest MBAS level (.076 mg/l) of all the stream samples. Conductivity up to 256 µmhos, probably a result of the contribution of flow from the spring. Meets water quality criteria for drinking water, aquatic life and bathing. |
| 3 | Hog lot Runoff | Fecal coliform MPN high at 2730/100 ml, exceeding drinking water standard. Nitrate nitrogen concentration (2.14 mg/l) was higher than at stations 1 and 2 (.56 and .75 mg/l). Nitrate levels similar to other surface streams in the area. Fecal coliform densities and nitrates due to hog lot runoff. Nitrates indicate stabilized wastes. Meets water quality criteria for aquatic life. | Zero flow. |
| 4 | Apple Grove Drainage before Parker Cave | Fecal coliform MPN of 1420/100 ml is less than station 3, but still was high, exceeding standards for secondary, contact recreation. Meets water quality criteria for drinking water and aquatic life. | Fecal coliform MPN up, 1500/ml. Nitrate nitrogen concentration (2.94 mg/l) several times larger than upstream samples.<br>Nitrates may be from stabilized animal wastes or fertilizers. Meets water quality criteria for drinking water and aquatic life. |

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* Includes-statement regarding water quality criteria. These conclusions are based only upon the grab samples and do not necessarily reflect water quality at all times.

TABLE III-6 SUMMARY NOTES ON RESULTS OF GRAB SAMPLES AT EACH SAMPLING SITE DURING MODERATE AND LOW FLOW SAMPLING CONDITIONS (Cont'd.)

| SAMPLE STATION | DESCRIPTION | MODERATE FLOW COMMENT | BASE FLOW COMMENT |
|---|---|---|---|
| 5 | Parker River (near cave entrance) | Nitrate nitrogen higher than any other stream sample (5.8 mg/1), typical of runoff in agricultural areas. Meets water quality criteria for drinking, aquatic life, and bathing. | Nitrate nitrogen down from moderate flow sampling (1.81 mg/1) since runoff source is not present. Meets water quality criteria for drinking, aquatic life and bathing. |
| 6 | Parker River (downstream from Apple Grove tributary) | Total dissolved solids (TDS) (608 mg/1) sulfate (136 mg/1) and chloride (200 mg/1) levels are higher than all other stream samples. Indication of oil brine pollution, but still meets drinking water standards. The point of chloride pollution is not known. It is likely that the Apple Grove drainage stream is contaminated between its sinking point and its confluence with Parker River. Meets water quality criteria for drinking water, aquatic life, and bathing. | Nitrate nitrogen higher than station 4 (5.36 mg/1). Conductivity (5,130 μmhos/cm) and TDS (3,400 mg/1) exceed drinking water standards. However, blind fish and blind crayfish are present in stream. Meets water quality criteria for aquatic life. |
| 7 | Sulfur Spring tributary to Parker River | Known source of chloride and sulfate contamination. Supported by data; chloride (184 mg/1) and sulfate (26 mg/1). However, this contamination is less than that detected at station 6. Meets water quality criteria for aquatic life. | Chloride and sulfate contamination is again evident. However, chloride level of 1,180 mg/1 far exceeds drinking water standard of 250 mg/1. Aquatic life appear to be unaffected. Meets water quality criteria for aquatic life. |
| 8 | Brown River | Suspended solids of 29 mg/1 indicates runoff. Total phosphorus of .116 mg/1 is higher than other streams in the area possibly due to agricultural runoff. Meets water quality criteria for drinking waters and aquatic life. | Water of high quality, $BOD_5$ approximately 0 and dissolved oxygen $\geq 8.4$ mg/1. Nitrate nitrogen is 3.35 mg/1, typical of area waters. Meets water quality criteria for drinking waters, aquatic life, and bathing. |
| 9 | Parker River (final sample in Parker Cave) | TDS (560 mg/1), conductivity (600 μmhos/cm), sulfate (128 mg/1) and chloride (180 mg/1) levels remain high due to upstream sources (stations 6 and 7). Zinc concentration of 0.108 mg/1 is higher than other streams.<br>Zinc concentrations appear to be from runoff. Although this concentration would be toxic to some fish, blindfish appear to be unaffected as many were seen during sampling. Meets water quality criteria for drinking water, aquatic life and bathing. | TDS (2520 mg/1), conductivity (3,740 mg/1), again are high. Nitrate nitrogen at 6.5 mg/1 is higher than stations 6 and 7. Nitrate possibly indicates stabilized pollutants. Meets water quality criteria for aquatic life and bathing. |

TABLE III-6 . SUMMARY NOTES ON RESULTS OF GRAB SAMPLES AT EACH SAMPLING SITE DURING MODERATE AND LOW FLOW SAMPLING CONDITIONS (Cont'd.)

| SAMPLE STATION | DESCRIPTION | MODERATE FLOW COMMENT | BASE FLOW COMMENT |
|---|---|---|---|
| 10 | North Creek headwaters (small subsurface drainage area) | Water quality excellent. Good indicator of ambient water quality. Nitrate nitrogen concentration 3.98 mg/l. Meets water quality criteria for drinking water, aquatic life, and bathing. | Nitrate nitrogen 4.00 mg/l best example of typical "unpolluted" groundwater. Meets water quality criteria for drinking water, aquatic life, and bathing. |
| 11&12 | Phantom Sulfur Spring Area | No samples collected | Represents extreme chloride and sulfate pollution. Significant quantities of $H_2S$ also present indicating reducing conditions (low oxygen levels). Chloride concentration at the spring 8,920 mg/l and sulfate 247 mg/l. Sulfide (as S) present (9.3 mg/l). No fish life in the waters. |
| 14 | Mill Hole | Water quality excellent. Fecal coliform MPN level of 320/100 ml less than 2000/100 ml criteria for secondary contact recreation. Relatively low fecal coliform for the large amount of runoff flowing to Mill Hole. Meets water quality criteria for drinking water, aquatic life and secondary contact recreation. | Water quality excellent at base flow. Dissolved oxygen about 8.5 mg/l and fecal coliform MPN of 120/100 ml meets water quality criteria for bathing waters. Meets water quality criteria for drinking water, aquatic life, and bathing. |
| 15 | Cedar Sink (mod. flow)<br>Owl Cave (base flow) | Water quality excellent. Fecal coliform MPN of 140/100 ml meets bathing water criteria. $BOD_5$ low - 1.2 mg/l.<br>No evidence of pollution from Park City wastewaters. Meets water quality criteria for drinking water, aquatic life and bathing. | Water quality excellent; $BOD_5 < 1$ mg/l, D.O. about 8.1 mg/l and a fecal coliform MPN of 0/100 ml. No evidence of pollution from Park City wastewaters. Meets water quality criteria for drinking water, aquatic life, and bathing. |
| 16 | Echo River | Water quality excellent, no evidence of pollution. Meets water quality criteria for drinking water, aquatic life, and bathing. | Water quality excellent, no evidence of pollution. Meets water quality criteria for drinking water, aquatic life, and bathing. |

TABLE III-6 . SUMMARY NOTES ON RESULTS OF GRAB SAMPLES AT EACH SAMPLING SITE
DURING MODERATE AND LOW FLOW SAMPLING CONDITIONS (Cont'd.)

| SAMPLE STATION | DESCRIPTION | MODERATE FLOW COMMENT | BASE FLOW COMMENT |
|---|---|---|---|
| 17 | South Branch Hidden River Cave | Data indicate severe pollution from Horse Cave STP. Trace metals contamination, high water temperature (13° C) for cave waters, high BOD$_5$ (133 mg/l) almost as strong as raw sewage (200 mg/l) and dissolved oxygen of 3.9 mg/l. Not suitable for aquatic life. Other pollutants evident in high concentration TDS, TSS, MBAS, ammonia nitrogen and sulfate. | Data indicate cave is still severely polluted by the Horse Cave STP. Trace metals concentrations down from moderate flow conditions due to Ken Dec, Inc. pre-treatment facilities. Some metals concentrations still toxic to some aquatic life (e.g. Copper, Zinc, Chromium). Water temperature of 19° C and D.O. level 2.7 mg/l. Little oxygen in air or water. Severe stench coming from entrance to cave. Will not support aquatic life. |
| 18 | East Branch Hidden River | Water quality excellent. No significant evidence of pollution - Nitrate nitrogen - 3.79 mg/l. Meets water quality criteria for drinking water, aquatic life and bathing. | BOD$_5$ high for natural waters (8.9 mg/l) indicating organic pollution, fecal coliform MPN of 17,500/100 ml is very high. High conductivity and TDS. D.O. level, however, was 7.9 mg/l. Data seems to support Quinlan's report that during low flow the East Branch is contaminated by the South Branch by seepage under the rocks immediately upstream from their confluence. Cave City could contribute some pollution, however, it is not considered likely that D.O. levels could be as high as 7.9 mg/l for long at BOD$_5$ concentrations of 8.9 mg/l. This indicates recent contamination. Meets water quality criteria for aquatic life. |
| 19 | Blue Spring Branch | Water quality excellent. No evidence of pollution. Fecal coliform MPN 0/100 ml. Meets water quality criteria for drinking water, aquatic life, and bathing. | Water quality generally good to excellent. Meets water quality criteria for drinking water, aquatic life and bathing. |
| 20 | L & N Cave | Water quality excellent. Meets water quality criteria for drinking water, aquatic life and bathing. | Water quality generally good. However, nitrate level is very high compared with all other sampling locations. Nitrate concentration of 10 mg/l is equal to maximum allowed for drinking water. Source may be stabilized wastes or fertilizer. Meets water quality criteria for drinking water, aquatic life and bathing. |

TABLE III-6 . SUMMARY NOTES ON RESULTS OF GRAB SAMPLES AT EACH SAMPLING SITE
DURING MODERATE AND LOW FLOW SAMPLING CONDITIONS (Cont'd.)

<table>
<tr><th>SAMPLE STATION</th><th>DESCRIPTION</th><th>MODERATE FLOW COMMENT</th><th>BASE FLOW COMMENT</th></tr>
<tr><td>21</td><td>Mick Spring (mod. flow)<br>Gorin Mill Spring (base flow)</td><td>Water quality excellent. Heavy metals from Horse Cave STP not detected. D.O. near saturation, 10.6 mg/l. Meets water quality criteria for drinking water, aquatic life and bathing.</td><td>Water quality poor. With respect to D.O. level of 2.7 mg/l this is too low to support aquatic life. Slight odor detected. However, fecal coliform MPN of 0/100 ml and BOD<sub>5</sub> of 1.2 mg/l are indicative of high quality waters.<br><br>Low levels of all pollutants appear to indicate that low D.O. is caused by lack of reaeration in the cave. Meets water quality criteria for drinking water and bathing.</td></tr>
<tr><td>26</td><td>Ken-Dec, Inc.<br>effluent</td><td>Heavy metals far exceed pre-treatment standards<br><table><tr><th></th><th>Ken-Dec mg/l</th><th>Pre-Treatment Standard mg/l (max. for any day)</th></tr><tr><td>Cr<sup>+6</sup></td><td>30.0</td><td>.25</td></tr><tr><td>Cr(total)</td><td>34.7</td><td>4.2</td></tr><tr><td>Ni</td><td>29.4</td><td>3.6</td></tr><tr><td>Cu</td><td>9.1</td><td>4.6</td></tr></table>Substantial quantities of grease and oil (63 mg/l)</td><td>Pre-treatment standard maintained for all heavy metals except hexavalent chromium (Cr<sup>+6</sup>). Sample indicates 0.44 mg/l. Grease and oil less than 3 mg/l.</td></tr>
<tr><td>27 & 28</td><td>Cave City Wastewater Treatment Plant<br>(influent and effluent)</td><td>Effluent BOD<sub>5</sub> and total suspended solids (TSS) very high, 148 mg/l and 198 mg/l respectively. Treatment plant functioning far below design efficiency. Grease and oil concentration (103 mg/l) is high. Ammonia nitrogen high - 24.4 mg/l.</td><td>BOD<sub>5</sub> and TSS near secondary treatment levels, 47 mg/l BOD<sub>5</sub> and 30 mg/l TSS. Efficiency much improved from moderate flow sampling conditions. Grease and oil about 11 mg/l and ammonia nitrogen about 28 mg/l.</td></tr>
</table>

TABLE III-6 . SUMMARY NOTES ON RESULTS OF GRAB SAMPLES AT EACH SAMPLING SITE DURING MODERATE AND LOW FLOW SAMPLING CONDITIONS (Cont'd.)

| SAMPLE STATION | DESCRIPTION | MODERATE FLOW COMMENT | BASE FLOW COMMENT |
|---|---|---|---|
| 29 & 30 | Horse Cave Wastewater Treatment Plant (influent and effluent) | Influent heavy metals concentrations are toxic to treatment plant microorganisms, exceeding even the pretreatment standards for metal plating facilities. | No influent comment |
| | | Effluent $BOD_5$ of 96 mg/l and TSS of 41 mg/l do not meet secondary treatment standards. However, some removal is experienced in spite of the adverse conditions. | Effluent $BOD_5$ of 361 mg/l and TSS of 151 mg/l are extremely high due to dumping of digestor supernatant on day of sampling. |
| | | Effluent concentrations of heavy metals are extremely high. | Effluent metals remain higher than normal wastewater treatment plants, but much reduced from moderate flow. |
| | | $Cr^{+6}$ 7.9 mg/l | $Cr^{+6}$ 0.06 mg/l |
| | | Cr(total) 16.7 mg/l | Cr(total) 2.42 mg/l |
| | | Ni 12.3 mg/l | Ni 3.57 mg/l |
| | | Cu 6.6 mg/l | Cu 0.59 mg/l |
| | | Zn 0.584 mg/l | |

## Turnhole Spring Basin

Overall, there appear to be no major pollution problems in this basin.

Dissolved Oxygen - In both moderate and base flow conditions D.O. concentration at all sampling stations exceeded the minimum requirement for maintaining aquatic life (5mg/l). In fact, all readings indicated greater than 75% saturation.

Nitrate Nitrogen - Nitrate nitrogen concentrations are not known to have a significant impact on aquatic life at levels found in even heavily polluted waters. All moderate and base flow grab samples indicate that nitrates are well within the range required for public drinking water supplies in the Turnhole Spring Basin. Major sources of nitrate in the basin include fertilizers and stabilized animal wastes.

Total Dissolved Solids (TDS) - Total dissolved solids concentrations were found to exceed the proposed Kentucky drinking water standards at five sampling locations in the Turnhole Spring Basin during base flow conditions, three sites in Parker River and at the two sampling stations at the Phantom Sulfur Spring. These dissolved solids levels appear to be due to chloride and sulfate pollution from brines leaking from abandoned oil wells.

TDS levels were found to be very high at Phantom Sulfur Spring, and no aquatic life was observed in the vicinity of the Spring. Lower TDS levels in Parker River do not appear to affect aquatic life.

Chloride - Chloride concentrations were found to exceed drinking water quality standards at three sampling locations in the Turnhole Spring Basin during base flow conditions.

Iron - Relatively high concentrations of iron were detected during moderate flow sampling in the Basin, while base flow sampling at the site of the highest iron concentration during moderate flow, indicated concentrations well within drinking water limits and the aquatic life criterion. There are two possible explanations for this:

1. Since moderate flow samples were collected following a rainfall soluble ferrous iron, present in soils as the result of anerobic conditions, may have been leached out, thus increasing iron concentrations.

2. Naturally occurring organometallic iron compounds may be carried into the streams with rainfall. Therefore, high iron concentrations appear to be temporary phenomena associated with runoff.

pH - All pH levels observed in the Turnhole Spring Basin under moderate and base flow conditions are within the acceptable range for aquatic life.

Fecal Coliform - With respect to fecal coliform densities, water quality in the Turnhole Spring Basin is good to excellent, with densities in some waters meeting bathing water criterion. No samples revealed any indication of significant human pollution.

## Hidden River Basin

The major known pollution problems in the study area are in the Hidden River Basin, primarily the result of the discharge of the Horse Cave wastewater treatment plant effluent to the South Branch of Hidden River Cave. Heavy organic loadings and high concentrations of trace metals have destroyed all aquatic life in the South Branch of Hidden River Cave and for some unknown distances downstream of the confluence with the East Branch. In addition, offensive odors resulting from organic decay emanate from the mouth of the cave and create a nuisance in the City of Horse Cave.

Dissolved Oxygen - Dissolved oxygen levels in South Branch Hidden River Cave during both moderate and base flow conditions are insufficient to maintain aquatic life. This is expected since organic loadings from the Horse Cave treatment plant are large and adequate dilution is not available in the South Branch. The most significant result of this sampling program is the extremely low D.O. concentration (2.5 mg/l) found in the waters of Gorin Mill Spring.

The following are conclusions from observations of $BOD_5$ and D.O. concentrations in the East Branch of Hidden River Cave:

1. The $BOD_5$ concentration is higher than generally found in unpolluted waters in the cave area.

2. The simultaneous occurance of "high" $BOD_5$ and D.O. concentrations may be due to organic pollution entering the East Branch immediately upstream from the sampling point or the result of aeration of the stream as it flows into Hidden River Cave.

Nitrate Nitrogen - The level of nitrate nitrogen found in the waters of LSN cave during base flow conditions were significantly higher than any other sampling station and is at the drinking water limit of 10 mg/l.

Total Dissolved Solids (TDS), Chloride and Sulfate - These parameters are not considered to be important indicators for assessing water quality in the Hidden River Basin since no significant sources were sampled other than the Horse Cave treatment facility. No analyses for chloride or sulfate were performed for the base flow samples. TDS levels under both base flow and moderate flow conditions meet drinking water criteria, with the exception of South Branch Hidden River Cave.

**Nickel** - Nickel concentrations in Hidden River Cave South Branch, as measured during base flow sampling, are in the range toxic to aquatic life.

**Copper** - Copper concentrations in South Branch Hidden River Cave, as measured during moderate and base flow sampling are toxic to aquatic life.

**Zinc** - Zinc concentrations in the South Branch of Hidden River Cave measured during base flow and moderate flow conditions, are toxic to some aquatic life. Concentrations measured during moderate flow conditions at Blue Spring Branch and L&N Cave indicate that these toxic levels may occur naturally during periods of runoff.

**Fecal Coliform** - Fecal coliform densities measured during baseflow and moderate flow conditions indicate that, with the exception of Hidden River Cave, waters sampled in the Hidden River basin are suitable for bathing purposes and do not appear to be subject to significant human or animal pollution. In Hidden River Cave South Branch, low concentrations during moderate flow are due to high metal concentrations while high fecal coliform levels during base flow conditions are typical of polluted waters.

## General Water Quality
## Turnhole Spring, Hidden River and Echo-Styx Basins

Results from the one-time grab sampling program indicates that pollution problems in Turnhole Spring Basin and Hidden River Basin appear to be localized. The only significant source of pollution detected in the Turnhole Spring basin is the Phantom Sulfur spring. In the Hidden River Basin while both Cave City and Horse Cave discharge wastewater treatment plant effluent to the subsurface waters, evidence of adverse effects on water quality observed in Hidden River Cave during the groundwater sampling program appear to be primarily attributable to the Horse Cave wastewater discharge . * However, it appears likely that some water quality problems, impossible to detect, may exist in the subsurface stream between Cave City and the East

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* Water Quality degradation in South Branch Hidden River Cave is due almost entirely to the Horse Cave wastewater discharge. Low D.O. levels downstream of the confluence of the East and South Branches may be partly due to the organic loading contributed by Cave City which enters Hidden River Cave via the East Branch. However, from operating data and base flow samples organic load to Hidden River Cave contributed by Cave City appears to be only approximately 15% of the total load under present conditions.

Horse Cave $BOD_5$ Loading = (265 mg/l BOD ) x (.34 mgd) x 8.34 = 750 lbs/day

Cave City $BOD_5$ Loading = (65 mg/l BOD ) x (.236 mgd) x 8.34 = 128 lbs/day

Cave City contribution = 128/878 = .15; this assumes no degradation of BOD prior to mixing of the East and South Branches.

Branch of Hidden River Cave. In addition, fecal coliform levels in the East Branch are extremely high, probably due to the Cave City discharge.

The toxic metals and heavy organic loadings resulting from the Horse Cave discharge have severely degraded water quality in the South Branch. However, the extent of water quality problems associated with the Horse Cave discharge is unknown. Even though the data indicate that pollutants are well diluted downstream in the Hidden River system, low D.O. levels observed in Gorin Mill Spring also show that the effects of the Horse Cave wastewater discharge, combined with a much smaller organic loading from the Cave City discharge, may extend far downstream from the confluence of the East and South Branches. Therefore, while pollution problems caused by toxic metals may be localized in South Branch and the vicinity immediately downstream, effects from organic pollution may be more widespread depending on conditions for reaeration in the Hidden River Cave System.

To assess the general water quality in the Turnhole Spring, Hidden River and Echo-Styx basins, samples of the final basin discharges to the Green River were collected (during both moderate and base flow) at Cedar Sink/Owl Cave, Hick Spring/Gorin Mill Spring and Echo River Spring, respectively. Each of these samples provides a composite of all the water in each basin.

With only two exceptions, water quality in these areas meets and/or exceeds the criteria for the use classifications of aquatic life, drinking water supply, and bathing. The zinc concentration, apparently a function of runoff, exceeds the toxic limit for some trout. Since the aquatic life in the area appear to be unaffected, this temporary higher level of zinc is considered acceptable for aquatic life. The other exception is somewhat more serious. The D.O. measured at Gorin Mill Spring is unacceptable for maintaining aquatic life. Since Gorin Mill Spring is the major discharge from the Hidden River Cave system, this may indicate that most of the waters of the Cave system are adversely affected by the organic loading from Horse Cave, combined with a smaller loading from Cave City, and are not capable of supporting aquatic life.

## Base Flow Extended Sampling Program

The base flow extended sampling program was developed to monitor changes in water quality at selected locations during critical baseflow conditions. The sampling stations included in the extended sampling are as follows:

| | |
|---|---|
| Turnhole Spring Basin | - Apple Grove drainage (#8)<br>- Mill Hole (#14) |
| Hidden River Basin | - L&N Cave (#20)<br>- Blue Spring Branch (#19)<br>- East Branch Hidden River Cave (#18)<br>- South Branch Hidden River Cave (#17)<br>- Gorin Mill Spring (#21) |

In waters that do not receive constant waste discharges but are more affected by pollution due to runoff conditions, the most critical period for water quality may not necessarily occur at the lowest stream flow but after a rainfall when runoff carries pollutants to streams and then subsides, leaving organic materials deposited in the stream beds to decay as the stream returns to base flow conditions. This type of pollution may be indicated by a temporary rise in nitrogen and a decrease in dissolved oxygen levels. The intention of the extended base flow sampling program is to detect these types of changes as well as expand the one-time grab sample data.

Again, as with the one-time grab samples, the following discussion includes only those results considered critical in assessing water quality or those which violated the water quality criteria defined by EPA (Table III-5).

Dissolved Oxygen - Of the parameters sampled during the program, D.O. is the most important and is likely to be the best indicator of organic pollution. With the exception of Hidden River Cave, South Branch and Gorin Mill Spring, D.O. levels at all stream sampling locations were found to be consistently greater than 5 mg/l, the aquatic life criterion.

Nitrogen - For waters not receiving wastewater discharge, no ammonia nitrogen concentrations above 0.05 mg/l were observed. Concentrations of all forms of nitrogen were observed to be higher in the South and East Branches of Hidden River Cave than in other streams due to wastewater discharges from Horse Cave and Cave City.

Heavy Metals (Total Chromium, Copper, Nickel and Zinc) - Although metal concentrations at the Horse Cave wastewater treatment plant have been greatly reduced, concentrations of nickel, chromium, copper and zinc in the South Branch Hidden River Cave, as indicated by the extended sampling program, remain at levels toxic to aquatic life.

Conductivity - The most significant conclusion of the conductivity sampling is that it provides another indicator that water quality in the natural waters in the area does not appear to change drastically with time.

## Limitations to the Sampling Program

Although the results of the sampling program provide an indication of water quality in the area, there are several limitations to the program that should be identified. They are as follows:

1. Except for the few parameters that were analyzed during the long-term base flow sampling program, sampling was not conducted during what is considered to be the "worst condition" - the effects of rainfall runoff during base flow.

2. Except for those parameters sampled during base flow, there is no replication of data.

3. Although the results are to apply to the entire study area, not all the subsurface basins were sampled.

4. Because of limited accessibility to subsurface sites, local pollution problems may be masked by dilution at the more accessible sites. (e.g. samples at Owl Cave show no effect of any Park City waste disposal.)

5. No seasonal data are presented since samples were only collected during two flow conditions.

Although there are limitations to the sampling program, several efforts were made to mitigate their effects:

1. The basins most subject to human pollution were sampled.

2. In addition, subsurface sampling in Parker Cave provided for monitoring the effects of runoff as waters moved through agricultural areas and did identify some local pollution problems.

3. Dissolved oxygen measurements were taken after rainfall during base flow conditions to obtain some indication of the effects of rainfall runoff.

4. The fact that the conclusions of the extended sampling do not differ from those of the one-time grab sampling program tends to support the findings of the program, however, limited.

## Conclusions

The findings of both the one-time grab sampling program and the extended base flow sampling program are consistent. The general conclusion of the sampling program is that based on the data, the water quality in the study area appears to be generally good to excellent, acceptable for maintaining aquatic life. However, there are known exceptions including the following:

1. Most of the waters of Hidden River Cave

2. Areas of local chloride pollution in the Turnhole Spring Basin

In addition, there are undoubtedly several areas of undetected local subsurface pollution problems in the study area, though they do not significantly affect overall water quality.

Because natural waters in the area appear to be generally of such high quality, application of the aquatic life criteria appears to be reasonable in most cases. However, a general classification of aquatic life for all waters in the area may be inappropriate depending upon local conditions.

To this point only aquatic life criteria for individual heavy metals are considered. However, because several heavy metals are present in the water at one time, it is necessary to also consider the effects of mixtures of heavy metals. An organism's ability to survive in one toxicant may not be a good indication that these levels are satisfactory when other toxicants are present. According to Dr. J. L. Weber (personal communication) and Arderson and Weber (1975), copper and nickel are concentration additive, and in combination with zinc, the effects are sometimes super-additive. When two or more toxic materials have additive effects, a reduction in the permissible concentrations may be necessary. An acceptable means of assuring that the combined amounts of several substances do not exceed a permissible concentration for the mixture is through the use of the following relationship:

$$\frac{Ca}{La} + \frac{Cb}{Lb} \; . \; . \; . \; + \frac{Cn}{Ln} \leq 1$$

Where C , C ...C are the measured concentrations of each of the toxic materials in the water and L , L ,...L are their respective permissible concentration limits derived for the materials on an individual basis (FWPCA, 1968). Should the sum of the several fractions exceed one, then a local restriction on the concentration of one or more of the substances is necessary.

Total metals concentrations are calculated using the above formula for copper, nickel and zinc. Levels of chromium, total and hexavalent, are considered to be so low as to be negligible outside of the South Branch Hidden River Cave. Therefore, these metals are not considered in the analysis of heavy metal mixtures. Non-conservative calculations are made using the limits for warmwater fishes (minnows, darters) because limits for the cave species are unknown. The limits used are as follows: nickel - 0.1 mg/l, copper - 0.05 mg/l and zinc 0.15 mg/l. More conservative calculations are prepared by using the zinc limit of 0.05 mg/l for more sensitive coldwater fish.

During moderate flow conditions, the non-conservative calculations indicate that total heavy metals may be excessive at stations 9, 17, and 20. Using the more conservative calculations, excessive metals concentrations are present in almost all of the sampling stations except stations 14 and 16, Mill Hole and Echo River respectively. These results are due primarily to the high zinc concentrations found during moderate flow conditions. As discussed previously, this appears to be a naturally occuring phenomenon, and because aquatic life was observed at all sites except South Branch Hidden River Cave, these levels appear to be satisfactory for maintaining the local aquatic species.

During low flow conditions, the non-conservative calculations indicate excessive heavy metal concentrations at stations 11 and 12, sites of known oil well contamination, and site 17, South Branch Hidden River Cave. Calculations from the data at the other sites indicate that heavy metals concentrations are not too high to support warmwater species. However, conservative calculations indicate that there may be a slightly high metals concentration in Brown River and Gorin Mill. In both cases, the calculation is 1.1, just slightly above the limit of 1. Organisms may not be affected in areas where heavy metals occur naturally because the heavy metals may be in a non-biologically active state. Weber (personal communication) mentioned that metals in a mixture are capable of combining with other elements or each other, effectively rendering themselves biologically inactive. Based on observations made during field sampling, heavy metals in the groundwater basins outside of the Hidden River Cave complex do not appear to limit or adversely affect aquatic life. It will be necessary, however, to set stringent limits on the heavy metals discharged from Ken-Dec. Levels may have to be less than the acceptable limit established by EPA for each metal separately. For example, the present safe limit for nickel is 0.1 mg/l and for Cu, 0.05 mg/l for warmwater fish. Considering additive effects, however, concentrations of these toxic elements in wastewater discharges may be required to be limited to levels that will assure that concentrations in the receiving stream do not exceed 0.05 mg/l nickel and 0.25 mg/l copper.

## 10. CAVE ECOLOGY

### Cave Systems

Subsurface aquatic and terrestrial communities are nearly complete in their dependence upon energy produced outside of the cave, although a small amount of energy is fixed by bacteria. Cave streams obtain nearly all of their energy budget from surface waters and sink holes. The rate of this flow is dependent upon the manner in which surface and subsurface streams transfer materials. The cave stream receives the entire budget of the surface waters through gravel, silt, sand or other material thereby decreasing the energy content by partially blocking the flow of organic material. Also common is the input of water via sinkholes with variable amounts of filtering. Water may also seep through porous rock to form drip pools or streams.

The energy budget of a terrestrial cave community is derived from surface terrestrial systems and subsurface aquatic systems. It is discontinuous in nature and patchy in distribution (Kane and Poulson 1976). Food items may be imported directly by such activity as the nocturnal surface feeding of the cave cricket (*Hadenoecus subterraneus*), the input of cricket feces to the subsurface terrestrial system, and the introduction of materials or feces by surface species. Subsurface streams deposit material by flooding and subsequent recession.

This relatively small energy budget for cave communities is reflected in both the aquatic and terrestrial systems by communities consisting of few species with low density, diversity, and biomass. Larger predacious cave species typically have low turnover rates associated with low reproductive rates and long life expectancies (Barr 1976; Poulson 1964).

In conjunction with the low energy budgets, cave species have adapted to a relatively constant environment. Two of the more important physical parameters are temperature and humidity which are subject to extremes at the cave entrance and vary less as the distance into the cave increases. The deep cave area is typified by relatively constant temperature and humidity. The distribution of food availability generally decreases as one progresses from a cave entrance to the deep cave zone. This is paralleled in the biotic parameters for both aquatic and terrestrial cave systems. The number of species, diversity, biomass, and amount of organics in the substrate decreases with increased distance from the entrance (Poulson & White 1969).

When compared with other cave systems the biota of the Mammoth Cave/Flint Ridge system is extremely diverse. Barr (1967) cites three major reasons for this relatively large diversity: cave size, amount of study, and geographical/geological location. Approximately 200 animal species have been collected in Mammoth Cave. Of these, 22% are obligatory cave dwellers, meaning that they must live and reproduce deep within the cave. Thirty-six percent of the animals are facultative cave dwellers which can survive inside or outside of caves. Twenty-two percent are species that are restricted to the entrance and twilight areas, and 20% are accidentals, cave animals which cannot complete their life histories within the cave zone.

## Karst Area Pollution

There have been several well documented ground water and cave pollution incidents within the EIS study area. Hidden River Cave had excellent water quality until the early 1930's. Oil refinery waste was dumped into a sink hole south of Hidden River Cave in 1931 and appeared in the cave. At present, extremely degraded conditions exist due to effluent from the Cave City and Horse Cave Treatment Facility, the latter of which includes waste with heavy metals and creamery waste.

An additional dairy product problem occurred in 1970 when an estimated 340 tons of whey were dumped into a sinkhole approximately 5 miles southeast of Smith Grove. This action resulted in the fouling of the Smith Grove water supply for more than one month, at which time the water quality improved to its previous quality.

Sewage effluent spills have been reported on two occasions at the Great Onyx Civilian Conservation Center (Job Corps). The initial spill was from a single lagoon system. The effluent flowed approximately 100 yards across the surface to a fissure where it is known to have entered the cave system. A second spill of chlorinated effluent occurred through a valve in the pipeline to the Green River.

The presence of buried fuel tanks at the Job Corp site is a threat to the cave fauna, although no leakage is known from these tanks. Fuel related incidents do pose a threat to the cave systems.

From February until November of 1975 approximately 4000 gallons of gasoline leaked from underground tanks in Horse Cave. A similar gas related incident occurred near Cave City on December 1, 1978. A full 1,800 gallon tanker truck spilled an undetermined amount of gasoline. While some of the fuel spilled into a farm pond, the majority of the spill seeped in the ground (Glasgow Daily Times: Dec. 3, 1978).

These specific examples emphasize the general vulnerability of cave systems to surface and subsurface pollution sources. Major Karst area pollution concerns for this study area include the impacts of subsurface discharges, septic systems, urban runoff, pipeline leaks, transportation accidents, storage facility leaks and dumping activities.

## Pollution Effects

Pollution effects on cave biota can be generalized into two categories: direct toxic effects and habitat modifications. Cave species are seldom utilized for toxicity studies since stocks are generally difficult to maintain and comparatively difficult to obtain. However, several pollutants have been shown to be directly toxic, including some heavy metals (Barr 1976) and chlorine (Mathews et al. 1977). Acute toxicity effects are generally similar to comparable surface species and the toxicological literature can generally be applied to cave species. However, since some cave species have long life cycles, they may be particularly susceptible to long term chronic pollution sources and the effects of bioaccumulation.

The indirect effects of habitat modification are generally more common in cave systems. As caves are low energy systems, an increase in food or carbon loadings can disrupt cave communities. These increases can upset species compositions within existing community populations or can facilitate the introduction of new species. Other habitat modifications include changes in local hydrology, cave moisture, sediment loads and water quality. Since cave communities have generally adapted to stable environmental conditions the modification of the prevailing environmental conditions typically leads to a disruption of the cave biota.

However, specific impacts on cave biota are seldom observed and are difficult to estimate. The obvious reasons for the scarcity of observed effects are the inaccessability of most cave and groundwater systems, the limited amount of biotic survey work done on most known cave systems and the difficulty of demonstrating direct causal relationships from pollution events. The study area is distinctive in that it has comparatively extensive biotic survey work both in terms of number of sites attracted and length of observations per site. The long term observation of Hidden River Cave has permitted the documentation of pollution impacts to this cave system (Austin 1978). The length of stream which is affected by the pollution is extremely difficult to estimate. However, it is becoming possible to anticipate general impact areas associated with surface activities and water pollution due to the dilineation of underground drainage basins. (Quinlan et al. 1977 and 1978).

In summary, the study area represents one of the major cave resources in the world. The cave biota is extremely sensitive to surface and subsurface pollution activity. While it is often difficult to observe and document impacts from pollution activity, the documental causes of cave pollution in the study area have demonstrated severe impacts to cave systems.

## 11. SURFACE ECOSYSTEMS

### Aquatic Ecology

Aquatic ecosystems in the study area can be categorized as surface and subsurface. Subsurface aquatic systems predominate and are discussed in the cave ecology section. Lotic (flowing water) systems include sinking streams, springs, karst windows and surface streams. The major surface stream within the study area is the Green River. Lentic (standing water) systems include ponds, lakes, and upland swamps.

Water flow in the area can be generalized as originating in the numerous small springs and swamps in the Glasgow Upland. These subsurface streams may resurface in the sinkhole plain. The subsurface streams may resurface in the sinkhole plain as sinking streams, springs or karst windows. Surface flow in the sinkhole plain is extremely limited. The subsurface water discharges at springs along the Green River in the study area and along the Barren and Little Barren Rivers in the outlying areas.

The predominance of subsurface drainage in the study area has a tremendous influence on the aquatic community. Based on limited sampling, the general impression of the aquatic invertebrate communities in the sinking streams and springs of the area is that the communities generally have a low diversity and a low density, but often contain pollution intolerant species.

Aquatic invertebrates of the surface streams have not been studied extensively in the study area. However, an overall assessment of invertebrate samples collected for this study indicates that pollution impacts to the major surface streams is minimal.

There were no fish kills reported in the study area from 1975 to 1977. There are no current sampling or stocking programs of fish populations in the study area. Water quality in the Green River is normally high, and there is no indication of the fish community being impacted by the current pollution loads.

Several studies have been conducted on the mussel community of the Green River. The mussel fauna is described as extensive above the pool area of Lock No. 6. Several mussel species on the Federal Endangered Species List have been identified as possibly present in the general study area and are discussed below.

## Terrestrial Ecology

The terrestrial environment of the study area has been modified by the clear cutting of forests and farming and suitable areas. The degree of agricultural modification is associated with the severity of the local topography. Relatively flat areas have been clear cut while areas with steep slopes have been selectively cut. A few areas of extreme relief have not been disturbed. Most areas outside the national park are currently in agricultural land use.

Total farm areas count for 57% of the study area with over 36% of that land under active cultivation. The important crops of the region include corn, sorghum, wheat, hay, tobacco, and pasture. Cattle and tobacco are the major cash crops of the area. The rate of forest recovery, or secondary succession, of old field systems varies with substrate type and prior land management. Abandoned agricultural land shows the slowest rate of succession and floodplains show the quickest recovery. Dominant species in any old fields system depends on prior use and any restocking activities.

Forest area calculations are based on aerial photo interpretation and forests account for almost 43% of the land use. Faller (1975) has detailed the forests of the Mammoth Cave National Park, and since the park was established with the purchases of small private farms, his conclusions can be assumed valid for the remainder of the study area. He identifies three major plant community types within the area:

> Mixed Woods Association - the most widely distributed association characterized by northern red oak, white oak, tulip tree, sugar maple and red maple. Four sub-types of this association are identified and are found across a moisture gradient.
>
> Floodplain Association - naturally associated with the Green River and subject to at least occasional flooding. Dominants include sycamore, greenash, box elder and silver maple.
>
> Upland Woods Association - dominated by oaks and less diverse than mixed wood slope stands. Selective cutting has limited the area of mature stands.

The complex plant communities of the study area and the protection afforded by Mammoth Cave National Park support a diverse animal community. The mosaic of farm and forest land produces a large edge effect which further enhances the area in terms of wildlife habitat.

## 12. RARE AND ENDANGERED SPECIES

The rare and endangered flora and fauna of the Commonwealth of Kentucky are currently protected by federal legislation. Section 7(C) of the Endangered Species Act of 1973, amended in 1978, requires federal agencies to provide for a consideration of the impacts of any federal activity on species which were listed or are proposed to be listed under the act. In the past, protection was also afforded by Kentucky state law. However, subsequent legislative action removed state protection.

The U.S. Fish and Wildlife Service (FWS) currently lists 15 species of concern which may be within the four counties of the study area (Hart, Barren, Edmonson, Warren). Due to the geographical limitation of the alternatives and the habitat requirements of the species, many of the species can be eliminated from consideration of impacts. Only listed species and species proposed for listing are legally protected or considered in federal agency biological assessment procedures. Formerly proposed species and species on the Smithsonian Institution's list of threatened plants are not included in the assessment requirements. Endangered species are currently listed in three categories by FWS. Category 1 species include taxa for which the service presently has sufficient information on hand to support the biological appropriateness of their being listed as endangered or threatened species. Category 2 species include taxa for which sufficient information is not presently available to support biologically a proposed listing as endangered or threatened but for which FWS posesses information indicating probable appropriateness for listing. Category 3 taxa are no longer being considered for listing.

### U.S. Fish and Wildlife Service - Species of Concern

1. Indiana bat - Myotis sodalis - Endangered. Coach Cave, Edmonson County is one of the listed critical habitats for this species. During winter, the Indiana bat hibernates in caves that have stable, cool temperatures (acceptable range - 3.0 to 17.0 C). Summer habitant consists of tree hollows and loose bark on dead trees where small nursery colonies roost. Foraging habitat is air space around tree crowns in the vicinity of streams. Humphrey (1978) reports that between 87 and 97% of the total Indiana bat population occupy only seven caves during the winter. Seventy-five percent of the population wintering in Kentucky is found in Bat Cave in Carter County. Estimates indicate a Kentucky population of 56,000 individuals in 1975-a 73% decline since 1955. Major

population impacts are the result of vandalisms, cave commercialization, and changes in air circulation and temperature. None of the alternatives include any activities which would directly impact the Coach Cave winter populations.

2. Gray bat - Myotis grisescens - Endangered. Very intolerant of human disturbance. Population of James Cave, Edmonson County, has decreased from 100,000 to 69,000 between 1960 to 1975. The gray bat has a narrowly restricted cave habitat. Summer nursery colonies have not been observed in caves having air temperatures below 13 C. Winter hibernation is generally in caves with a temperature range between 6 and 9 C. Winter caves must provide continuously low temperatures but be without danger of freezing. The species is highly colonial and migrates between winter and summer caves. Major population impacts can be caused by any human disturbance during hibernation, modification of cave entrances to restrict bat movement or changes in air temperature. The alternatives do not propose activities which will directly impact the James Cave population.

3. Pink mucket pearly mussel - Lampsilis orbiculata orbiculata - Endangered. Possibly in area. Known in Green River at Lock 5 and from Munfordville area (Stansberry - Personal Communication). Species requires flowing water with low sedimentation rates and gravel substrate.

4. Tuberculed blossom pearly mussel - Epioblasma torulosa torulosa - Endangered. Known to be present from Munfordville downstream to impoundment of Green River within park (Stansberry). Does not tolerate slack water or sediment buildup.

5. Green blossom pearly mussel - Epioblasma torulosa gubernaculum - Endangered. Reported from Green River in 1926. Review of specimens in Carnegie Museum by Stansberry indicate that the species was probably misidentified. Known from the Upper Tennessee River system. Probably not present in study area.

6. Rough pigtoe pearly mussel - Pleurobema plenum - Endangered. Collected in Green River by both Stansberry and Williams. Known from riffle area above Munfordville and flowing river areas downstream as well as from the Clinch River system. Requires moving water, moderately clean water quality and low sedimentation rates.

7. Orange-footed pearly mussel - Plethobasis cooperianus - Endangered. Restricted to the Tennessee River. The only recent records of this species are from the Lower Tennessee system. Neither Williams nor Stansberry has any collections or knowledge of this species ever being recorded in the study area.

8. Red-cockaded woodpecker - Picoides borealis - Endangered. Very rare in Kentucky and some authorities believe this species no longer exists in the state. All records from 1960 - 1975 were from McCreary, Lawel, Pulaski, Russell, and Whitley Counties. Red-cockaded woodpeckers are associated with stands of mature to overmature pines. This is one of the few birds which excavates its nesting and roosting cavities in living trees. These cavities

are generally made in old pine infected with fungus disease (Fomes pini) which softens the heartwood. Current timber management practices are the primary impact to this species. Alternatives should not impact this species.

9. Kentucky cave shrimp - Palaemonias ganteri - Proposed Endangered. Species is known only from the Flint Mammoth Cave system in the Mammoth Cave National Park. The habitat requirements include relatively quiet pools which receive seasonal sediment deposits by flooding. Recent sitings in the park have confirmed its continued presence. Population has been impacted by the flooding of lower level cave passages by the impoundment of the Green River at Lock 6. Dye tracing by Quinlan et al indicates that surface activities outside the park and within the study area can impact this species. Regional alternatives which serve the Park City, Cave City, and major transportation routes (Hwy 70) would provide maximum protection from existing and future development in terms of sewerage. It should be noted that since all alternatives propose improved wastewater management for the study area, improved water quality is anticipated with all alternatives. Protection from additional problems associated with development including non-point source pollution, storage tank leaks and transportation accidents and spills are not addressed in this EIS and are measures to be developed through local zoning and land use controls.

10. Armigerous river snail - Ioarmigesa asmigera - Formerly proposed endangered. The genus Io includes the largest and most spectacular of the North American river-snails (Family Pleuroceridae). The genus is wholly endemic to the rock ledges and swift water of the Upper Tennessee River system. This species is no longer proposed for listing as endangered.

11. False foxglove - Aureolaria patula - Formerly proposed endangered. Currently Category 1. Found along wooded river bluffs, central Kentucky to north Georgia.

12. Groundnut - Apios priceana - Formerly proposed endangered. Currently Category 1. Found in rocky woods and thickets in Tennessee and Kentucky.

13. French's Shooting Star - Dodecatheon frenchii - Smithsonian Institution's list of threatened plants. Currently Category 2. Found under overhanging cliffs, southwest Wisconsin, south Illinois, and west Kentucky.

14. Synandra - Synandra hispidula - Smithsonian Institution's list of threatened plants. Currently Category 2. Mint found in wet woods and along stream banks. Tennessee to Illinois, Ohio and Virginia.

15. Gladecress - Leavenworthia toralosa - Smithsonian Institution's list of threatened plants. Currently Category 2. Species restricted to moist cedar glades. North Alabama, Tennessee, and Kentucky.

## PART C. EXISTING MAN-MADE ENVIRONMENT

### 1. POPULATION CHARACTERISTICS

There are five population centers within the Mammoth Cave Study Area. They are the towns of Munfordville, Horse Cave, Cave City and Park City. The Mammoth Cave National Park may also be considered a population center during the summer months because of the large number of tourists visiting the park. "Cave Country" visitation, in addition, significantly increases the summer populations in the towns of Horse Cave, Cave City and Park City as they provide tourist accomodations. The study area outside the towns is sparsely populated, with only about 30-40 people per square mile.

Population projections for the study area were made by population center since there are no defined surface drainage basins in the sinkhole plain and attempts to disaggregate populations in the study area according to drainage sub-basins are considered inappropriate. Table III-7 presents population projections for the study area population centers. These projections were developed by the Kentucky Program Development Office (KPDO) for each municipality.

Because the Mammoth Cave National Park draws an estimated 11,000 people/day during the summer months, the peak seasonal "population" of the park is considered to be very important in providing water and sewerage services in the area even though a smaller tourist population is present throughout the year.

The National Park Master Plan provides visitation projections to the year 2000. However, visitation during the past 5 years indicate that these projections may be somewhat optimistic. Newer projections developed for a transportation plan presently being prepared for the Park estimate daily average cave visits to be 7,100-7,800 during July-August of 2000. This represents a total of about 14,200-15,600 park visitors. These projections also indicate that peak cave visitation during the summer months is expected to reach 10,600-11,700 cave visits per day on many week-ends and holidays. (See Table III-7).

### 2. LAND USE

The rural characteristics of the study area are reflected in the fact that most study area land uses fall within the categories of agricultural, forested or vacant land use. The four small communities of Munfordville, Horse Cave, Cave City and Park City serve as centers of residential, commercial and industrial land use in the study area.

Two major influences on land use in the study area are Mammoth Cave National Park and Interstate 65. Mammoth Cave National Park comprises over 51,000 acres. Over the past 25 years visitations to the park have increased dramatically, with an all time high of 675,167 persons reached in 1973.

## TABLE III-7

## KENTUCKY PROGRAM DEVELOPMENT OFFICE POPULATION PROJECTIONS & MAMMOTH CAVE NATIONAL PARK PROJECTED VISITATION (VISITORS/DAY)

| Population Center | 1970 Census | 1980 | 1990 | 2000 |
|---|---|---|---|---|
| Horse Cave | 2,068 | 2,019* | 2,712<br>(2,960)[1] | 3,093<br>(3,380)[1] |
| Cave City | 1,818 | 1,997* | 2,230<br>(2,440)[1] | 2,470<br>(2,700)[1] |
| Munfordville | 1,233 | 1,788* | 1,473<br>(1,860)[1] | 1,614<br>(2,040)[1] |
| Park City | 567 | 603* | 672<br>( 750)[1] | 723<br>( 850)[1] |
| Mammoth Cave National Park | | | | |
| Average Daily Cave/ Peak Cave Visits July-August Visitation | | 5,200/ 7,700 | 6,400/ 9,500 | 7,500/11,100 |
| Average Daily Total/ Peak Park Visits July-August Visitation | | 10,400/15,400 | 12,800/18,900 | 15,000/22,200 |

[1]( ) Projections developed by GFC&C, Inc.

* 1980 Preliminary Census figures

Sources: Comprehensive Water and Sewer Report. 1973. BRADD

Mr. James Brockway. Urban Studies Center. University of Louisville. Personal Conversation. March, 1981

Year 2000 projections developed by Qilliam S. Pollard, Consultants, Memphis, Tennessee. (National Park)

Gannett Fleming Corddry and Carpenter, Inc.

The major impact of the park and increasing visitation has been the proliferation of tourist related activities in the area such as motels, restaurants, service stations, and camping grounds. Most of this activity has focused around the I-65 interchange at Cave City where a variety of commercial activities related to the park's tourism have been developed. Other minor commercial activity has developed at the I-65 interchanges at Cave City and Horse Cave.

Another major consideration is EPA's policy on the protection of significant agricultural lands. Conversion of prime agricultural farmland to non-agricultural uses has been recognized as a major environmental concern. In 1978, EPA adopted a policy of preventing the loss of significant agricultural lands which result from the agency's actions. EPA policy and regulations specifically discourage allocating federal funds to sewer interceptors that cross prime agricultural lands, unless they are needed to eliminate pollution or public health violations in existing developments and even those systems may not provide capacity for new development on the agricultural land.

Little existing land use planning or zoning activity exists in the study area. Neither Hart nor Edmonson Counties has a planning or zoning commission. Therefore, there is no comprehensive plan or zoning or subdivision regulations for either county. Barren County on the other hand, has a joint City-County Planning Commission which includes Barren County and the cities of Cave City, Park City and several others not in the study area.

Future land use is expected to reflect the influence of Mammoth Cave National Park. One major impact on future land use would be the park's plan to construct a new staging area at Chaumont on the periphery of the park. Location of this staging site could have a significant influence on the I-65 interchange at Park City since this exit would be the closest to the proposed terminal and staging area. This could result in a proliferation of tourist services in the area between Park City and the park entrance.

The following descriptions of expected future land use suggest that no dramatic changes in land use will occur regardless of the influence of the national park.

Residential - Residential land use will be characterized by growth outside incorporated cities in scattered low density developments adjacent to existing urban areas and along major transportation routes.

Commercial - Commercial growth will be characterized by the development of tourist-oriented business along roads leading into the national park. Also, commercial facilities are expected to be located on the outer fringes of study area municipalities.

Industrial - Major industrial development is not expected in the study area, as the study area's economy becomes increasingly dominated by the tourist business. Industries located in the area will select sites close to I-65 interchanges or to L&N Railroad facilities.

Public/Semi-Public - This category includes land uses such as recreation and open space, public facilities and transportation facilities. The major existing public facility in the study area is the Mammoth Cave National Park.

Agriculture, Woodlands and Vacant - This land use is now and will continue as the major land use in the study area. However, as farming and forestry activity dwindles, more and more land will convert to vacant status. In addition, this land use will be encroached upon by other land uses as there are demands for additional residential, commercial or industrial land.

## 3. ECONOMIC CONDITIONS

### Introduction

For many years agriculture or agriculturally related employment has dominated study area economy. Recently, however, agriculture as a focal point of employment has given way to manufacturing as the major employer in the study area. From 1950 to the present the area has become less dependent upon agriculture, as agricultural employment has declined, and fewer farms and amounts of land are available for farming activity.

### Employment

Employment data was available only on a county-basis. The two largest employers in the three county area are agriculture and manufacturing. Data indicate overall increases in manufacturing employment for each county between 1971 and 1976, and an increase in agricultural employment for the same time period in Barren County and decreases in both Hart and Edmonson Counties.

| County/Year | | Agriculture | Manufacturing |
|---|---|---|---|
| Barren | | | |
| | 1971 | 2,550 | 3,000 |
| | 1976 | 2,880 | 4,056 |
| Edmonson | | | |
| | 1971 | 590 | 380 |
| | 1976 | 273 | 428 |
| Hart | | | |
| | 1971 | 4,710 | 590 |
| | 1976 | 5,812 | 648 |

Table III-8 presents employment by industry for each study area county for 1975 and 1976. This table, again, indicates that agricul-

## TABLE III-8

## EMPLOYMENT BY INDUSTRY, BY PLACE OF WORK: 1975 & 1976

| County | Agricultural | Non-Agricultural | All Industries 1975 | All Industries 1976 | Mining & Quarrying 1975 | Mining & Quarrying 1976 | Contract Construction 1975 | Contract Construction 1976 | Manufacturing 1975 | Manufacturing 1976 |
|---|---|---|---|---|---|---|---|---|---|---|
| BARREN | 2,667 | 11,886 | 8,554 | 9,394 | 93 | 76 | 432 | 476 | 3,658 | 4,056 |
| EDMONSON | 252 | 2,804 | 873 | 921 | 44 | 12 | 15 | 20 | 388 | 428 |
| HART | 1,427 | 4,208 | 1,854 | 1,849 | 22 | 21 | 82 | 89 | 592 | 648 |
| TOTAL | 4,346 | 18,898 | 11,281 | 12,164 | 159 | 109 | 529 | 585 | 4,638 | 5,132 |

| County | Transportation Comm. & Public Utilities 1975 | Transportation Comm. & Public Utilities 1976 | Wholesale & Retail Trade 1975 | Wholesale & Retail Trade 1976 | Financial Ins. & Real Estate 1975 | Financial Ins. & Real Estate 1976 | Services 1975 | Services 1976 | Other 1975 | Other 1976 |
|---|---|---|---|---|---|---|---|---|---|---|
| BARREN | 452 | 470 | 2,180 | 2,444 | 322 | 323 | 1,377 | 1,510 | 40 | 39 |
| EDMONSON | 10 | 11 | 239 | 151 | 53 | 43 | 120 | 252 | * | 4 |
| HART | 145 | 70 | 693 | 709 | 56 | 59 | 262 | 251 | * | * |
| TOTAL | 607 | 551 | 3,112 | 3,304 | 431 | 425 | 1,759 | 2,013 | 40 | 43 |

* Not disclosed.

Sources: Kentucky Department for Human Resources, Kentucky Labor Force Estimates, Annual Averages, 1975.
Kentucky Department for Human Resources, Average Monthly Workers Covered by KY Unemployment Insurance Law, 1975 & 1976.
BRADD 1978 Date Book.

ture and manufacturing are the top two employers in the study area, followed by Wholesale & Retail Trade and Services.

Table III-9 presents Labor Force Characteristics for the three counties. Included here are number in the labor force, number employed and unemployed and unemployment rate. Unemployment in the study area has been relatively insignificant in Barren and Hart Counties. Edmonson County, on the other hand, has experienced significant unemployment.

### Income

Income data is presented here on a county level for Total Personal, Per Capita Personal and Median Family Income. In 1977, Total Personal Income (Thousands) was $171,000 for Barren County, $34,000 for Edmonson County and $64,000 for Hart County. Per Capita Personal Income for the same year was $5,543,, $3,431 and $4,188 for Barren, Edmonson, and Hart Counties, respectively. These figures fall well below the Kentucky per capita income figure of $7,342 and the U.S. figure of $8,706. Median family incomes for the counties are also well below national levels. Median family incomes include $8,700 for Barren County, $6,700 for Hart County and $6,500 for Edmonson County.

### Retail Business Trends

A study of retail business trends in the study area includes the review of sales and number of establishments. The three county study area suffered a net loss of 5 retail establishments from 1948 to 1972. Barren County is the only county showing a net increase, probably due to growth in Glasgow and development associated with tourism at the national park. Retail sales volumes increased from 25,000 in 1948 to 57,110 in 1968, with some of this probably caused by inflation during the period 1948 to 1967. It appears that the major influence of increased visitation at the national park has been within Barren County and that construction of I-65 or increased visitation at the park has had no influence on retail activity in either Hart or Edmonson Counties.

## 4. CULTURAL RESOURCES

Cultural resources include both prehistoric resources commonly associated with archeological sites and with historic resources associated with land marks. The Mammoth Cave area has numerous archeological and historical resources. These resources are mapped on Figure III-4.

## TABLE III-9

## LABOR FORCE CHARACTERISTICS

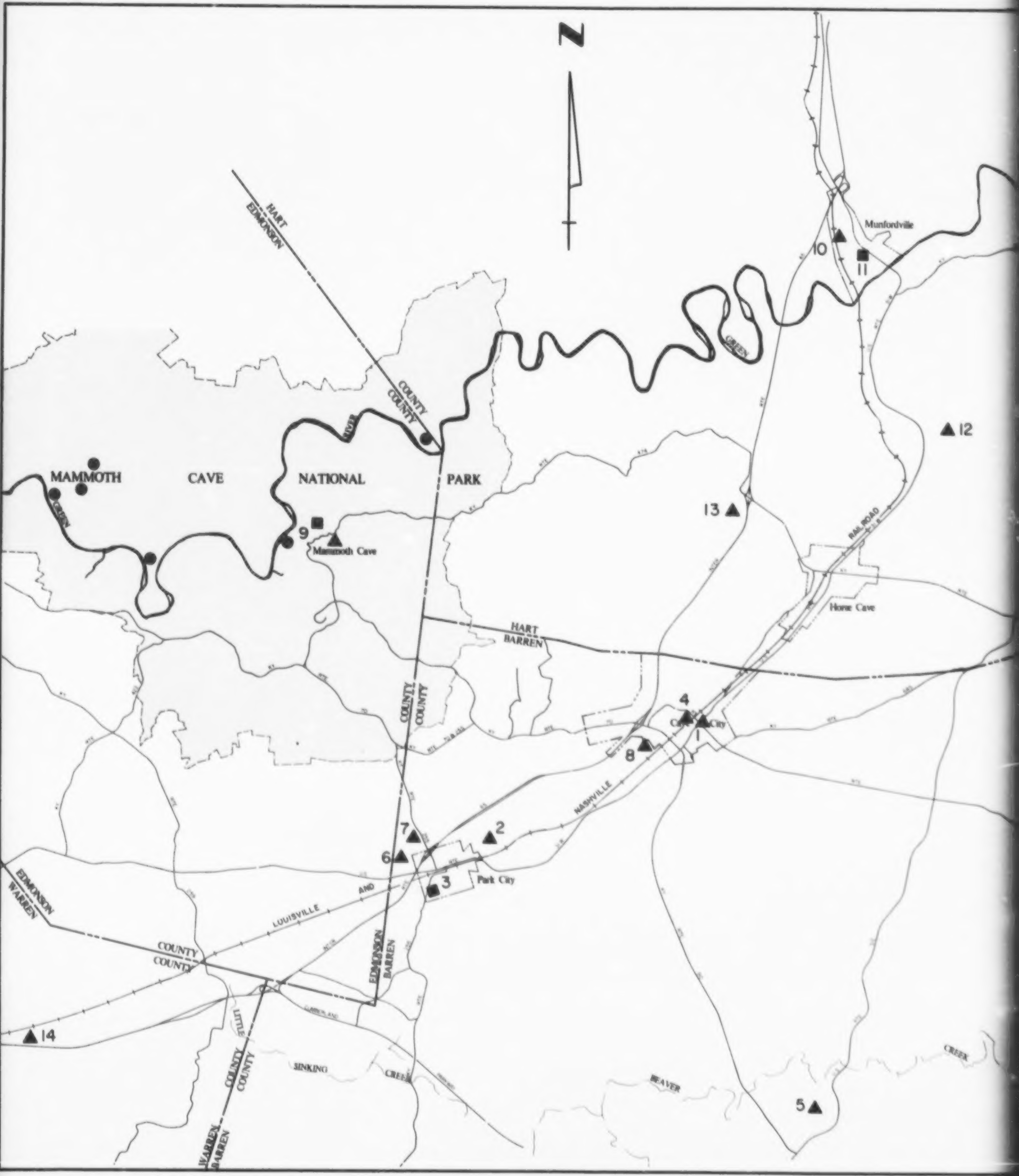
| | Barren County | | | Edmonson County | | | Hart County | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1960 | 1970 | 1975 | 1960 | 1970 | 1975 | 1960 | 1970 | 1975 |
| Total County Population | 28,303 | 28,677 | 30,590 | 8,085 | 8,751 | 9,584 | 14,119 | 13,980 | 15,701 |
| [1]16 Years & Older | 20,337 | 20,417 | 22,604 | 5,680 | 6,133 | 6,775 | 9,960 | 9,709 | 11,037 |
| No. in Labor Force | 10,402 | 11,350 | 16,600 | 2,145 | 2,710 | 3,616 | 4,837 | 4,940 | 5,137 |
| Percent in Labor Force | 51.0 | 55.6 | 73.4 | 37.8 | 44.2 | 53.3 | 48.6 | 50.9 | 55.6 |
| No. Employed | 9,986 | 10,973 | 15,845 | 1,965 | 2,506 | 3,256 | 4,504 | 4,679 | 5,812 |
| Percent Employed | 95.7 | 96.7 | 95.5 | 91.6 | 92.5 | 90.0 | 93.1 | 94.7 | 94.7 |
| No. Unemployed | 416 | 377 | 755 | 180 | 204 | 360 | 333 | 261 | 325 |
| Percent Unemployed | 4.3 | 3.3 | 4.5 | 8.4 | 7.5 | 10.0 | 6.9 | 5.3 | 5.3 |
| Unemployment Rate | 4.4[2] | 5.0 | 9.1 | 18.1[2] | 20.0 | 10.1 | 4.5[2] | 5.6 | 7.9 |

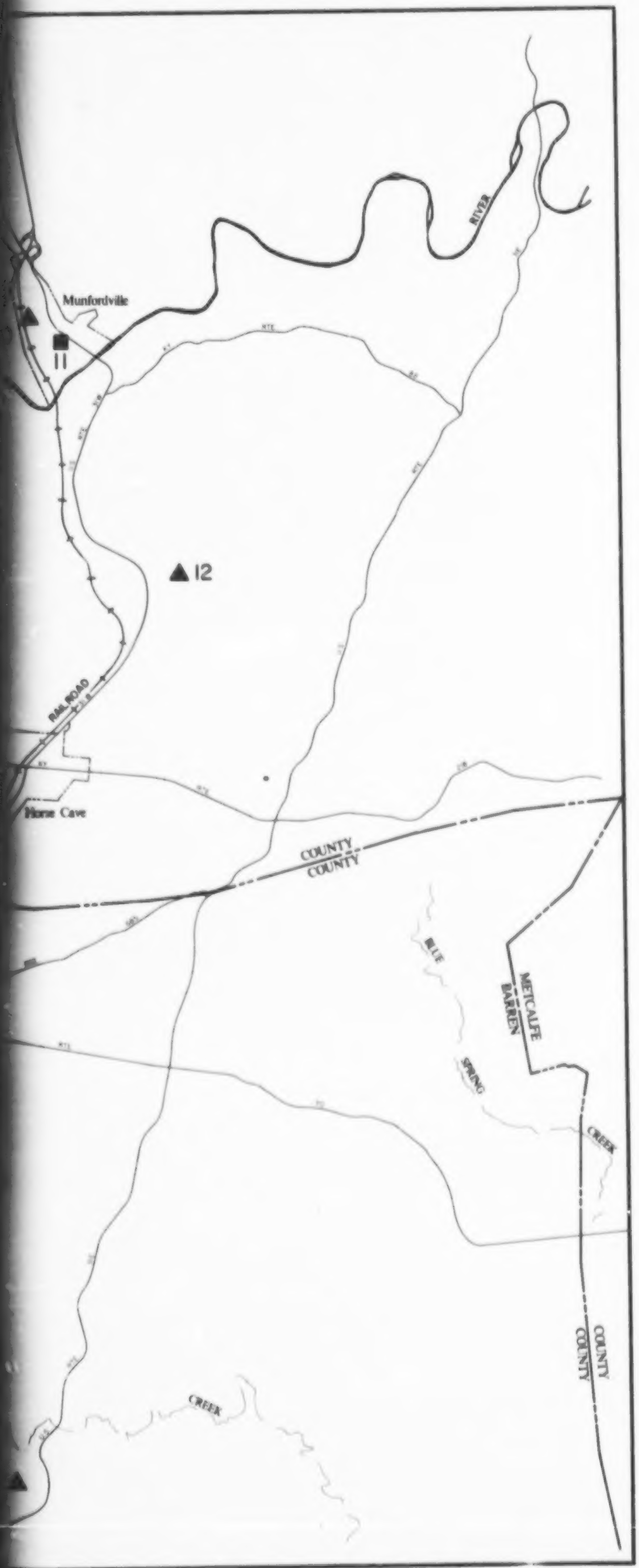
U.S. Labor Force
Participation Rates - 1960 - 55.3 1970 - 60.3

[1] In 1960 Labor Force Characteristics included all persons 14 years and older. In 1970 the U.S. Census Bureau changed labor force designation from 14 years to 16 years.

[2] 1965 data

Sources: BRADD 1978 Data Book.
BRADD Integrated Program Design - June, 1977.


N
HART
EDMONSON
COUNTY
COUNTY
MAMMOTH
CAVE
NATIONAL
PARK
GREEN
RIVER
9
Mammoth Cave
Munfordville
10
11
GREEN
12
13
RAILROAD
Horse Cave
HART
BARREN
COUNTY
COUNTY
4
Cave
City
1
8
NASHVILLE
7
2
6
3
Park City
LOUISVILLE
AND
EDMONSON
WARREN
COUNTY
COUNTY
EDMONSON
BARREN
14
LITTLE
SINKING
CREEK
BEAVER
CREEK
5
WARREN
BARREN
COUNTY
COUNTY


RIVER
Munfordville
11
12
RAILROAD
Horse Cave
COUNTY
COUNTY
BLUE
SPRING
CREEK
METCALFE
BARREN
COUNTY
COUNTY
CREEK

## LEGEND

▭ MAMMOTH CAVE NATIONAL PARK

● ARCHEOLOGICAL SITES

■ HISTORICAL SITES

▲ RECREATIONAL SITES

NOTE: NUMBERS CORRESPOND TO NUMBERS LISTED ON TABLE II-29

FIGURE III-4

MAMMOTH CAVE AREA
201 FACILITIES PLAN

ENVIRONMENTAL IMPACT STATEMENT

## ARCHEOLOGICAL, HISTORICAL AND RECREATIONAL SITES

12,000 6000 0 12,000 24,000
Scale In Feet

U.S. Environmental Protection Agency
Region IV Atlanta, Georgia

### Archaeological Resources

During prehistoric times, peoples of four Indian cultures (Paleo-Indian, Archaic Indian, Woodland Indian, and Mississippian Indian) inhabited the Mammoth Cave area. The caves were not used extensively for any purpose during any of the four periods. Probably the greatest use was by the Woodland Indians (1000 B.C. to 400 A.D.) who utilized the caves at times for shelter and storage.

### Historical Resources

Only one resource within the study area has been placed on the National Register of Historic Places, Department of Interior. This resource is the replica of Hercules and Coach No. 2, the locomotive that took visitors from Glasgow Junction (now Park City) to Mammoth Cave from 1886-1931. There are numerous other historic sites within the national park including the Historic Entrance which led to discovery of the cave, remains of huts from Dr. John Croghan's unsuccessful hospital for tuberculosis patients, relics from salt petre mining operations within the cave, and the casket and farmhouse of Floyd Collins, discoverer and explorer of caves in the area. Of historic interest are the hotel and three one-room frame churches.

There are two historic sites outside the park, Bell's Tavern in Park City and Old Munford Inn in Munfordville.

## 5. RECREATIONAL RESOURCES

Mammoth Cave National Park is the most important recreational resource in this area. The park is located primarily in Edmonson County with small portions in Barren and Hart Counties. Within the park are the most extensive caverns and some of the finest examples of karst topography in the world, abundant wildlife, and artifacts of ancient people. The park offers a variety of activities that vary in number and type throughout the season.

There are few parks in the study area. This is due to the fact that the area is primarily rural, the communities are small, and the Mammoth Cave National Park, Barren River State Park and the Nolin River Lake are close to the communities. Cave City, Park City and Munfordville have city parks and area schools provide playground facilities for area residents. Table III-10 lists the existing and planned recreational areas within the study area. Figure III-4 maps these recreational areas.

The area has potential for increased recreational facilities. There are many caves on private property that would provide spelunkers with a variety of caves ranging from easily explored to challenging. The large amounts of marginal agricultural land and forested areas

TABLE III-10. EXISTING AND PLANNED RECREATIONAL AREAS WITHIN THE STUDY AREA

| County | Map I.D.# ** | Facility | Ownership | Total Acreage | Comments |
|---|---|---|---|---|---|
| Barren | 1 | Cave City Park | City | 12 | |
| | 2 | Park City Lion's Club | City | 50 | |
| | 3 | Bell's Tavern | Private | N.A. | Historic site |
| | 4 | Caveland Golf | Private | N.A. | |
| | 5 | Glasgow Golf & Country Club | Private | N.A. | |
| | 6 | Park Mammoth Resort | Private | N.A. | |
| | 7 | Diamond Caverns KOA | Private | N.A. | 63 camp spaces |
| | 8 | Yogi Bear Campground | Private | N.A. | 100 camp spaces |
| | * | Mini-park in Cave City | | | |
| | * | Mini-park in Park City | | | |
| Edmonson | 9 | Mammoth Cave National Park | Federal | 51,000 | |
| Hart | 10 | VFW Park | City | 5 | |
| | 11 | Old Munford Inn | Private | N.A. | Historic site |
| | 12 | Caveland Country Club | Semi-Private | N.A. | |
| | 13 | KOA Campground | Private | N.A. | 50 camp spaces |
| | * | Mini-park in Horse Cave | | | |
| | * | Neighborhood park in Horse Cave | | | |
| Warren | 14 | Ed Spear Park | County | 9.5 | Fishing available |

* Recreational needs

** Refers to Figure III-4

Source: An Open Space and Recreation Plan, BRADD could be used for campgrounds. Fishing and swimming are limited because of the scarcity of surface water in the area.

Discussion of the usage of recreational facilities in the area will be limited to use of the National Park. A large percent of the Park's visitors originate within Kentucky and the four heavily industrialized states to the north. The numbers of visitors to both the park and the caves have been increasing. In 1952, 217,015 persons visited the caves. By 1975 this figure had increased to 650,000. During those same years the park experienced a 400% increase in visitation from 400,000 to 2,000,000 visitors.

## 6. TRANSPORTATION

Of the major components of the transportation system, highway, air, rail and water, only the highway and rail systems have any significant impact in the study area. There are no navigable waters in the study area. In addition, the nearest air service is limited and located in Bowling Green, Kentucky about 22 miles south of Park City.

Three Federally numbered highways serve the study area, I-65, US 31-W and US 31-E. Important State numbered highways serving the area include the Cumberland Parkway and Kentucky routes 70, 90, and 255.

| Road | Service Area |
|---|---|
| a. I-65 | a. traverses middle of study area and serves as a major link between Chicago to the North and Mobile to the South. |
| b. US 31-E | b. western part of the study area |
| c. US 31-W | c. replaced by I-65; local connection for four study area municipalities. |
| d. Cumberland Parkway | d. passes through southern portion of the study area, connecting area with eastern Kentucky |
| e. Kentucky 70 | e. serves as major highway in the southern portion of the national park. |
| f. Kentucky 90 | f. enters study area from the south, connecting Cave City and Glasgow, Kentucky. |

| | |
|---|---|
| q. Kentucky 255 | q. major access to national park from south. |

There are at present no mass transit systems in the planning area. However, the Mammoth Cave National Park Master Plan calls for providing "a public transit system that will eliminate congestion created by privately operated vehicles and that will supply efficient comfortable transportation for park visitors". Interstate bus service is available at each of the municipalities with north-south I-65 connections provided by Greyhound.

There are two railroads servicing the study area. One, the L&N Railroad provides freight service to study area municipalities. Passenger service is provided by Amtrak located in Bowling Green, Kentucky.

## 7. RESOURCE USE

Most of the area is in agricultural and silvicultural use (Table III-11). Agricultural lands are used for both crops and pasture. Corn for grain, soybeans, clover and hay are grown. Marginal croplands are used for pasturing primarily hogs and cattle.

The forested areas are primarily eastern red cedar, scrub oak and hickory hardwood, some of which are used for timber. The forested areas in the Mammoth Cave National Park are not cut for commercial purposes. Forest lands are increasing slightly as marginal agricultural lands are stocked with trees. The percent commercial forest of total land area in each county is shown below. The portion of Warren County in the study area is primarily agricultural land.

| County | Percent |
|---|---|
| Barren | 7.0 |
| Edmonson | 39.0 |
| Hart | 43.1 |
| Warren | 25.8 |

A section of the study area contains high calcium limestone reserves that are not heavily mined. There are no strip mines or coal reserves in the area.

Oil and natural gas resources within the study area are located around and north of Glasgow, the eastern tip of Warren County, west of Munfordville, near Cave City, east of Hiseville, and in northeastern Barren County and southeastern Hart County. Petroleum and natural gas production is not high.

## TABLE III-11

## RESOURCE USE BY COUNTY WITHIN THE STUDY AREA

| County | Land Area Used Each Year (Sq. Miles) | | |
|---|---|---|---|
| | 1960 | 1970 | 1975 |
| **Barren** | 486 | 486 | 486 |
| Agriculture | 363 | 346 | 346 |
| Forest | 105 | 122 | 122 |
| Mining | 0 | 0 | 0 |
| Edmonson | | | |
| Agriculture | 120 | 123 | 123 |
| Forest | 176 | 106 | 106 |
| Mining | 0 | 0 | 0 |
| Hart | | | |
| Agriculture | 239 | 234 | 234 |
| Forest | 175 | 168 | 168 |
| Mining | 0 | 0 | 0 |
| Warren | | | |
| Agriculture | 399 | 382 | 382 |
| Forest | 125 | 142 | 142 |
| Mining | 0 | 0 | 0 |

Source: The River Basin Water Quality Management Plan for Kentucky.
Vol. 3. Green River Basin.

## 8. WASTEWATER PROGRAMS AND SPECIAL PROBLEMS

### Wastewater Programs

The most appropriate method of treatment and disposal of wastewater in the Mammoth Cave area is the central issue of this environmental impact statement. In the study area there are five major population centers, the municipalities of Munfordville, Park City, Cave City and Horse Cave, as well as Mammoth Cave National Park (including the Great Onyx Job Corps Center). With the exception of Park City, these all maintain and operate wastewater treatment and disposal facilities. Besides these public facilities, there are non-municipal wastewater treatment plants scattered throughout the study area. In addition, sub-surface on-lot treatment and disposal (including direct discharge to sinkholes) is used extensively by individuals and commercial establishments in all areas not served by municipal sewerage facilities, including Park City. Figure III-5 shows the location of the treatment facilities in the study area, and the following section inventories those facilities.

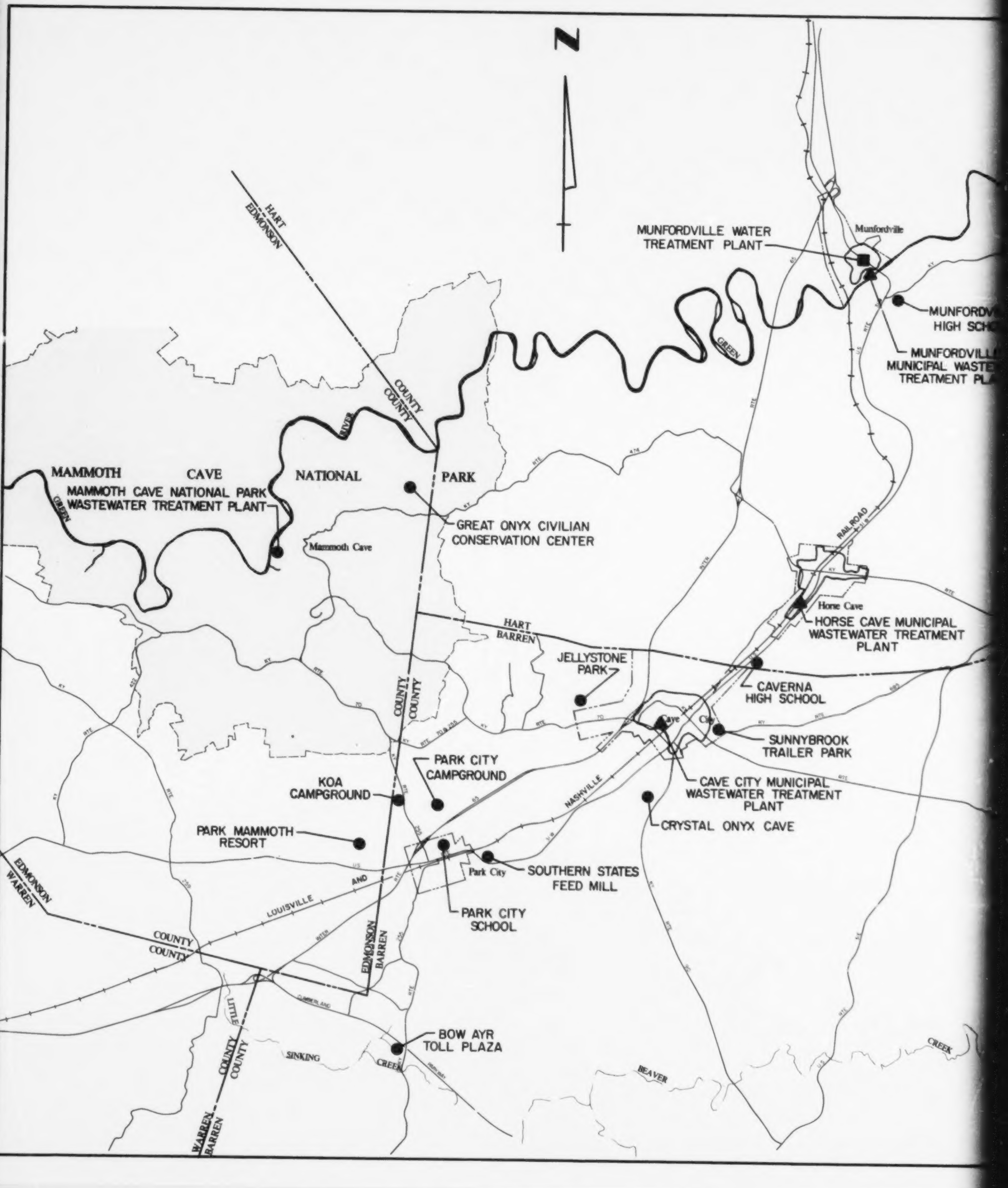
### Horse Cave Wastewater Facilities.

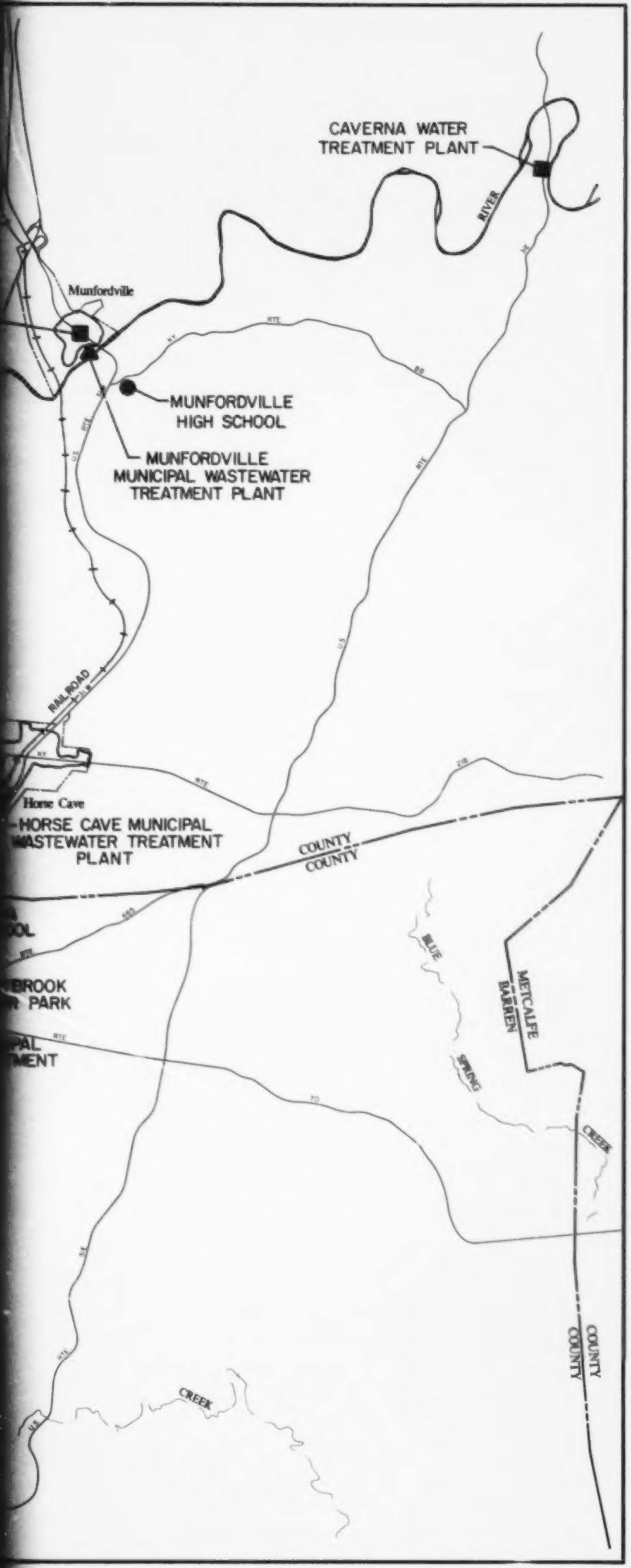
The Horse Cave wastewater treatment facility is a high-rate trickling filter plant designed for a hydraulic loading of 0.8 mgd and a BOD loading of approximately 870 lbs/day. The treatment plant should be capable of providing secondary treatment. Major wastewater treatment processes include grit removal, comminution, primary sedimentation, trickling filtration, secondary sedimentation and chlorination.

The treated effluent is discharged to the subsurface where it flows to the South Branch of Hidden River Cave. Sludge is treated in anaerobic digesters and dewatered with drying beds. Because of the metals contents in the sludge, disposal is prohibited in conventional landfills. Dried sludge is presently being stored at the plant site and plant personnel are awaiting instruction from the Kentucky Division of Hazardous Material and Waste Management for proper disposal.

The Horse Cave wastewater collection and treatment system serves about 90 percent of the water customers within the city's corporate limits. This includes two industrial customers, the Hart County Creamery and Ken-Dec, Inc. Also, an interceptor to serve the commercial establishments at the Horse Cave I-65 interchange was recently constructed. At this time, however, only the Rodeway Inn is discharging wastewater to the system.

Although Horse Cave has submitted an application, an NPDES discharge permit has not been issued for the Horse Cave wastewater treatment plant. Plant operations continue under the direction of a qualified operator with Class II certification.


N
HART
EDMONSON
COUNTY
COUNTY
MUNFORDVILLE WATER
TREATMENT PLANT
Munfordville
MUNFORDVI
HIGH SCHO
MUNFORDVILL
MUNICIPAL WASTE
TREATMENT PLA
GREEN
RIVER
MAMMOTH CAVE NATIONAL PARK
MAMMOTH CAVE NATIONAL PARK
WASTEWATER TREATMENT PLANT
GREEN
GREAT ONYX CIVILIAN
CONSERVATION CENTER
Mammoth Cave
RAILROAD
Horse Cave
HORSE CAVE MUNICIPAL
WASTEWATER TREATMENT
PLANT
HART
BARREN
JELLYSTONE
PARK
CAVERNA
HIGH SCHOOL
Cave City
SUNNYBROOK
TRAILER PARK
COUNTY
COUNTY
PARK CITY
CAMPGROUND
KOA
CAMPGROUND
CAVE CITY MUNICIPAL
WASTEWATER TREATMENT
PLANT
NASHVILLE
CRYSTAL ONYX CAVE
PARK MAMMOTH
RESORT
Park City
SOUTHERN STATES
FEED MILL
EDMONSON
WARREN
LOUISVILLE
AND
PARK CITY
SCHOOL
COUNTY
COUNTY
EDMONSON
BARREN
CUMBERLAND
LITTLE
SINKING
CREEK
BOW AYR
TOLL PLAZA
BEAVER
CREEK
COUNTY
COUNTY
WARREN
BARREN


CAVERNA WATER TREATMENT PLANT
RIVER
Munfordville
RTE
KY
88
MUNFORDVILLE HIGH SCHOOL
MUNFORDVILLE MUNICIPAL WASTEWATER TREATMENT PLANT
U.S.
RTE
RAILROAD
Horse Cave
HORSE CAVE MUNICIPAL WASTEWATER TREATMENT PLANT
218
COUNTY
COUNTY
OOL
BROOK
R PARK
PAL
MENT
BLUE
SPRING
CREEK
METCALFE
BARREN
COUNTY
COUNTY
CREEK

## LEGEND

▨ MAMMOTH CAVE NATIONAL PARK

☐ MUNICIPAL SEWERAGE SERVICE AR

● NON-MUNICIPAL

▲ MUNICIPAL

■ WATER TREATMENT FILTER BACKWAS
SEDIMENTATION

FIGURE III- 5

MAMMOTH CAVE AREA
201 FACILITIES PLAN

ENVIRONMENTAL IMPACT STATEMENT

## WASTEWATER TREATMENT FACILITIES

12,000 6000 0 12,000 24,000
Scale In Feet

U.S. Environmental Protection Agency
Region IV Atlanta, Georgia

## Plant Performance

Performance data is very limited because there is no regular monitoring program at the plant. Results of sampling performed at different times during the past three years, indicated unsatisfactory performance at the Horse Cave plant, due primarily to the industrial wastewaters discharged to the plant. Slightly over 50% of the daily average flow (0.37 - 0.39 mgd) is untreated industrial wastewater from the Hart County Creamery and Ken Dec's electroplating plant, resulting in influent high in BOD and heavy metals concentrations. An August 1977 sampling survey report indicated influent BOD as high as 2,000 mg/l and concentrations of chromium (total), copper and nickel of 16.6, 48.4 and 19.8 mg/l respectively (See Table III-12). Visual inspection of the facility (in September 1977 and March 1978) revealed that there is little biological growth on the trickling filter media and that the anaerobic digester is no longer operational, conditions apparently the result of toxic effects of chromium, copper and nickel.

It is evident that the Horse Cave treatment plant cannot provide secondary treatment under these existing conditions. Improved operations are expected with the installation of pre-treatment facilities at the Ken Dec electroplating plant which should reduce heavy metals concentrations to levels acceptable to permit biological treatment activities. However, present BOD loading already exceeds design capacity. Unless pre-treatment of the Hart County Creamery's wastewater is provided to reduce influent BOD , the Horse Cave treatment plant cannot be expected to produce the secondary treatment effluent for which it is designed.

## Munfordville Wastewater Facilities

The Munfordville Wastewater treatment plant is a 0.15 mgd extended aeration facility which discharges to the Green River about 200 feet downstream from the Highway 31 W bridge in Munfordville, Kentucky. Major plant equipment includes a bar screen, comminutor, grit chambers, Parshall flume with continuous flow measuring device, dual aeration basins and secondary clarifiers. In addition, the plant has a by-pass line following the influent flow measuring device.

The Munfordville Municipal Sewerage system serves approximately 50% (250 customers) of the population of the community. One industrial customer, a small slaughter house, discharges untreated wastewater to the plant, but it does not appear to affect the plant. The collection system consists of 6 in. and 10 in. sewers and includes two lift stations and force mains to serve low-lying areas of the community. The plant is operated under NPDES permit #KY0031755 by a qualified operator with a Class II sewer certification.

## TABLE III-12

## HORSE CAVE WASTEWATER TREATMENT PLANT

## PERFORMANCE DATA

| Date of Sample | Sample Collection | Type of Sample | Source | $BOD_5$ | SS | $NH_3$-N | pH | Cu | $Cr^{+6}$ | $Cr_T$ | Ni | Zn | Total Metals (Cr+Zn+Cu+Ni) | Cd | Pb | Fe |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10/22/75 (7:30 a.m.) | Kentucky Div. of W.Q. | Grab | Influent | 945 | 360 | | 5.7 | 2.72 | | 1.19 | 2.58 | 6.2 | 12.7 | .005 | .038 | .434 |
| 10/22/75 (7:30 a.m.) | Kentucky Div. of W.Q. | Grab | Effluent | 144 | 50 | | 6.8 | 1.6 | | 3.62 | 1.98 | 8.82 | 16. | .003 | .028 | .322 |
| 11/12/75 (10:30 a.m.) | Kentucky Div. of W.Q. | Grab | Influent | 987 | 233 | | | | | | | | | | | |
| 11/12/75 (10:30 a.m.) | Kentucky Div. of W.Q. | Grab | Effluent | 124 | 43 | | | | | | | | | | | |
| 12/4/75 (9:00 a.m.) | Kentucky Div. of W.Q. | Grab | Influent | 148 | 48 | | | | | | | | | | | |
| 12/4/75 (9:00 a.m.) | Kentucky Div. of W.Q. | Grab | Effluent | 106 | 32 | | | | | | | | | | | |
| 5/20/75 | Kenvirons, Inc. | Composite | Influent | 1081 | 340 | 20 | 7.2 | .732 | | 2.26 | 4.14 | 1.1 | 8.2 | .047 | .078 | 1.36 |
| 5/20/75 | Kenvirons, Inc. | Composite | Effluent | 405 | 153 | 12 | 6.9 | .458 | | 1.34 | 2.08 | .552 | 4.43 | .05 | .034 | .596 |
| 6/9/76 | Kenvirons, Inc. | Composite | Influent | 320 | 158 | 16.4 | 7.55 | 2.99 | | .932 | 1.48 | 1.06 | 6.46 | .002 | .046 | 1.05 |
| 6/9/76 | Kenvirons, Inc. | Composite | Effluent | 261 | 87 | 13.2 | 7.3 | 2.32 | | .333 | .932 | .576 | 4.16 | .003 | <.005 | .566 |
| 9/4/76 | T.A. Waters (operator) | Grab | Influent | | | | | 5.94 | | 130 | 24.6 | 15.8 | 176.3 | .007 | .226 | 1.32 |
| 9 [illegible] 76 | T.A. Waters | Grab | Influent | | | | | 3.2 | | 75 | 10.9 | 9.26 | 98.4 | .004 | .082 | 1.14 |
| 8/23/77 | Kentucky Div. of W.Q. | Composite | Influent | 316 | 320 | 12 | | 2.62 | | 10.5 | 6.36 | .778 | 20.2 | .002 | .046 | .642 |
| 8/23/77 | Kentucky Div. of W.Q. | Composite | Effluent | 202 | 76 | 6.6 | 7.2 | 1.64 | | 6.64 | 1.52 | .252 | 10.5 | .002 | .011 | .230 |
| 8/12/77 | T. A. Waters | Grab | Influent | | | | | 48.4 | | 16.6 | 19.8 | 2.6 | 87.4 | .003 | .074 | 1.22 |
| 8/23/77 | Kentucky Div. of W.Q. | Grab | Influent | 159 | 147 | | | | | | | | | | | |
| 8/24/77 | Kentucky Div. of W.Q. | Grab | Influent | 2153 | 686 | | | | | | | | | | | |
| 3/21/78 (11:00 a.m.) | GFCC, Inc. | Grab | Influent | 316 | 155 | 6.8 | 7.2 | 7.9 | 10.7 | 25.8 | 20.8 | .92 | 55.4 | <.005 | <0.1 | 0.83 |
| 3/21/78 (11:00 a.m.) | GFCC, Inc. | Grab | Effluent | 96 | 41 | 8.8 | 7.3 | 6.6 | 7.9 | 16.7 | 12.3 | .584 | 36.2 | <.005 | <0.1 | 0.78 |
| Pretreatment Standards for the Electroplating Industry (>10,000 gpd) | Average Daily Values for 30 Consecutive Days | | | - | - | - | 7.5-10 | 2.0 | .09 | 1.6 | 1.8 | 1.5 | 3.9 | 0.5 | 0.4 | - |
| | Maximum for any one (1) day | | | - | - | - | 10 | 4.6 | .25 | 4.2 | 3.6 | 3.4 | 7.5 | 1.0 | 0.8 | - |
| Typical Values for Municipal High-Rate Trickling Filter Plant | | | Influent | 200 | 200 | 25 | 6-9 | | | | | | | | | |
| | | | Effluent | 30 | 30 | 18 | 6-9 | | | | | | | | | |

## Plant Performance

Latest NPDES self-monitoring data and Kentucky Compliance Monitoring Analyses indicate that the plant is performing well, providing BOD reductions of about 95% and suspended solids reductions of about 90%. Table III-13 presents performance data for the plant. The plant effluent is in constant violation of NPDES fecal coliform limits, because there are no disinfection facilities.

The August, 1977 Compliance Monitoring Survey of the Munfordville, Kentucky sewage treatment facility reported that the continuous flow-measuring equipment was not usable due to problems with the float sensors. Although this equipment does not affect plant performance, continuous flow monitoring is required by Kentucky law.

Little or no waste sludge is produced at the Munfordville plant, since it is an extended aeration facility loaded at about 50% design capacity. As the plant reaches design capacities, the plan is to pump sludge from the secondary clarifier with a septic-tank truck and dispose by land spreading.

Some improvements are required immediately at the plant to meet Federal and State regulations, including continuous flow monitoring, disinfection facilities, and post aeration to meet NPDES dissolved oxygen requirements.

Plant performance and flow monitoring data provided by the Kentucky Division of Water Quality indicate that there is capacity to expand the present sewerage service area. However, flows should be carefully monitored during wet-weather periods to confirm this conclusion and to determine the amount, if any, of additional capacity.

## Cave City Wastewater Facilities

The Cave City treatment plant provides biological wastewater treatment by means of a high-rate trickling filter with a design capacity of 0.32 mgd. Other plant processes include grit removal, comminution, primary and secondary sedimentation, sludge digestion and chlorination. Continuous effluent flow-monitoring is provided. Sludge, dewatered on drying beds, is stored in large piles and used occasionally for land application by local farmers. Treated effluent is discharged to a sinkhole, together with siltrate from the sludge drying beds, and flows to the East Branch of Hidden River Cave according to results of recent dye tracing work performed by J. Quinlan (personal communication).

The Cave City sewerage system is maintained within the corporate limits of Cave City and serves about 600 customers (about 90% of the population) including commercial establishments. The collection system consists of 8-inch sewers with some 10-inch trunk lines carrying sewage to the treatment plant. Three pumping stations are used to lift wastewater from low areas to gravity sewers. The wastewater

## TABLE III-13
## MUNFORDVILLE WASTEWATER TREATMENT PLANT

### PERFORMANCE DATA

| | Monthly Average | $BOD_5$ (mg/l) | | Susp. Solids (mg/l) | | $NH_3$-N (mg/l) | D.O. (mg/l) | Fecal Coliform (N/100 ml) | Flow (mgd) |
|---|---|---|---|---|---|---|---|---|---|
| | *NPDES Permit Limits | 30 | | 30 | | 20 | 4 | 200 | 0.15 (568 $m^3$/day) |
| | | Inf. | Eff. | Inf. | Eff. | Eff. | Eff. | Eff. | |
| | August 3-4, 1977 (Composite sample by Kentucky Division of Water Quality) | 228 | 6 | 180 | 18 | 1.7 | - | - | 0.063 (238 $m^3$/day) |
| NPDES Self-Monitoring | October 1977 | 226 | 2 | 150 | 1 | 1.1 | 2.8 | 10,500,000 | - |
| | November 1977 | 289 | 5 | 225 | 3 | 2.1 | 1.3 | - | - |
| | December 1977 | 432 | 21 | 209 | 13 | 1.2 | 2.2 | 2,800 | - |

*Based on design flow of 0.15 mgd (568 $m^3$/day)

Source: NPDES Self-Monitoring Data.
Kentucky Division of Water Quality.

treatment plant is located near the L&N Railroad tracks (Figure III-5) and is surrounded by open fields. There appears to be ample space at the site for expanding and upgrading the treatment facilities.

## Performance Data

Table III-14 indicates that the Cave City treatment plant is not providing the level of treatment required by NPDES permit KY0025763. Even with ideal operating conditions, however, the treatment facility cannot be expected to meet these stringent discharge limits since the high-rate trickling filter is designed to provide only secondary treatment (85% $BOD_5$ removal).

Plant performance should be judged according to the plant's secondary treatment design criteria. Again, inspection of Table III-14 indicates that plant performance is not satisfactory. During the summer months, when efficiency should be at a peak, plant BOD removals are only 76% even when loaded below design capacity.

The actual daily average flow for the months of July and August, 1977 (peak of tourist season), is estimated to be about 0.22 mgd, approximately 0.1 mgd less than the plant's design capacity of 0.32 mgd. Since the $BOD_5$ concentration in the influent is typical for domestic wastewaters, it is expected that additional wastewaters (up to .32 mgd) may be treated without adversely affecting the plant's ability to provide secondary treatment.

## Mammoth Cave National Park Wastewater Facilities

Wastewater generated in the National Park at the Historic Entrance area, comfort station in Great Relief Hall of Mammoth Cave, and park residence and utility area is collected and treated at the park's wastewater treatment plant, located near the Green River (Figure III-5). The facility is a high-rate trickling filter plant with a design capacity of 120,000 gpd. Major plant units include an Imhoff tank (primary sedimentation and anaerobic sludge digestion), dual trickling filters, secondary clarifiers, chlorine contact chamber and sludge drying beds. Treated effluent is discharged to the Green River, while dried sludge is trucked to a local sanitary landfill in Edmonson County. Should the need arise, there is adequate space at the treatment plant site to accommodate additional treatment units.

## Plant Performance

Visual inspection of the plant has revealed that the plant is well operated and maintained, and plant operation data in Table III-15

# TABLE III-14
# CAVE CITY WASTEWATER TREATMENT PLANT
# NPDES PERMIT CONDITIONS

| Parameter | NPDES Permit Limits (Based on 0.406 mgd)(1537 $m^3$/day) | |
|---|---|---|
| | Monthly Average | Monthly Average Concentration |
| $BOD_5$ | 24 lbs/day(10.88 Kg/day) | 7 mg/1 |
| SS | 101 lbs/day(45.81 Kg/day) | 30 mg/1 |
| $NH_3$-N | 3.4 lbs/day(1.54 Kg/day) | 1 mg/1 |
| D.O. | - | 8 mg/1 |
| Fecal Coliform | - | 200 N/100 ml |
| pH | 6.9 | 6-9 |

## PLANT PERFORMANCE DATA

| | Month | Flow mgd ($m^3$/day) | $BOD_5$ (mg/1) | | Susp. Solids (mg/1) | | $BOD_5$ (lbs/day) | Susp. Solids (lbs/day) |
|---|---|---|---|---|---|---|---|---|
| | | | Inf. | Eff. | Inf. | Eff. | Eff. (Kg/day) | Eff. (Kg/day |
| NPDES Self-Monitoring | April 1977 | 0.189 (715) | - | - | - | - | - | - |
| | May 1977 | 0.174 (658) | - | - | - | - | - | - |
| | June 1977 | 0.203 (768) | - | 66 | - | 31 | 112 (50.80) | 52(23.59) |
| | July 1977 | 0.252 (954) | - | 61 | - | 27 | 128 (58.06) | 57(25.86) |
| | August 1977 | 0.252 (954) | - | 64 | - | 56 | 134 (60.78) | 118(53.52) |
| | September 1977 | 0.211 (799) | - | 56 | - | 42 | 98 (44.45) | 74(33.57) |
| | November 1977 | 0.128 (485) | - | 56 | - | 31 | 60 (27.22) | 33(14.97) |
| | December 1977 | 0.163 (617) | - | 53 | - | 40 | 72 (32.66) | 54(24.49) |
| Ky. Compliance Monitoring | August 23-24, 1977 | 0.209 (791) | 214 | 51 | 393 | 62 | 89 (40.37) | 108(48.99) |

*These flows are reported to be 14% too high according to Kentucky Division of Water Quality Plant Design is 0.32 mgd.

Source: NPDES Self-Monitoring Data.
Kentucky Compliance Monitoring Data.

## TABLE III-15

## MAMMOTH CAVE NATIONAL PARK WASTEWATER TREATMENT PLANT

## PERFORMANCE DATA

| Monthly Average NPDES Limit | Flow ($m^3$/day) * | $BOD_5$ (mg/l) 30 | | Susp. Solids (mg/l) | | $BOD_5$ (lbs/day) 30 (13.61 Kg/day) Effluent | Susp. Solids lbs/day 30 (13.61 Kg/day) Effluent | Plant $BOD_5$ Removal Efficiency % |
|---|---|---|---|---|---|---|---|---|
| | | Inf. | Eff. | Inf. | Eff. | | | |
| May 1977 | - | 160 | 30 | - | 25 | - | - | 81 |
| June | - | 180 | 23 | - | 18 | - | - | 87 |
| July | - | 190 | 16 | - | 10 | - | - | 93 |
| August | .075 - .085 mgd<br>(284 - 322) | 225 | 14 | - | 9 | - | - | 94 |
| September | 0.047 (178) | 159 | 10 | 105 | 10 | 4 (1.81) | 4 (1.81) | 94 |
| October | 0.049 (185) | 91 | 10 | 69 | 6 | 4 (1.81) | 2 ( .91) | 89 |
| November | 0.052 (197) | 92 | 10 | 51 | 10 | 4 (1.81) | 4 (1.81) | 89 |
| December | 0.078 (295) | 76 | 9 | 53 | 9 | 7 (3.18) | 7 (3.18) | 88 |
| January 1978 | 0.098 (371) | 71 | 12 | 60 | 6 | 10 (4.54) | 5 (2.27) | 83 |
| February | 0.098 (371) | 81 | 12 | 72 | 8 | 10 (4.54) | 7 (3.18) | 85 |
| March | 0.104 (394) | 89 | 16 | 68 | 7 | 14 (6.35) | 6 (2.72) | 82 |
| April | 0.061 (231) | 209 | 6 | 119 | 8 | 3 (1.36) | 4 (1.81) | 97 |

*Design flow is 120,000 gpd (454 $m^3$/day)

Source: NPDES Self-Monitoring Data.

confirms this. It is indicated in this table that the plant consistently provides secondary (or better) treatment in compliance with NPDES permit KY0021156. There are no known water quality violations due to the plant's discharge.

Although daily average flow during any month does not exceed design capacity, wastewater flows during wet weather periods regularly exceed this capacity. Not only are extremely high flows recorded immediately following rainfall or snow melt events, but that during periods of wet weather, flow is generally higher than even in the peak tourist season. For instance, in February 1978, when flow averaged 98,000 gpd, a maximum day of 280,000 gallons was recorded, 2.3 times design capacity. During the peak tourist season (July and August), the average daily flow to the plant is reported to be 75,000-85,000 gpd.

High flow during wet weather periods indicates the existance of an infiltration/inflow (I/I) problem in the Mammoth Cave system. Assuming the I/I problem can be eliminated, there appears to be sufficient capacity to accomodate greater wastewater flows due to the increased park visitation anticipated in the Mammoth Cave National Park Master Plan. Based on these projections, the plant appears to have adequate capacity to continue to provide secondary treatment until the mid 1980's. However, if wastewater from over the proposed staging area at Chaumont is treated at a different facility, the existing plant should have adequate capacity well after 1985.

### Great Onyx Civilian Conservation Center Wastewater Treatment Plant

Wastewater generated from activities at the Job Corps' Great Onyx Civilian Conservation Center is treated in three waste stabilization lagoons. Effluent from the lagoons is chlorinated before discharge to the Green River. The design capacity of the system is approximately 20,000 gpd to provide for a population of 200 at the center.

### Plant Performance

Monitoring data indicate that the lagoon system is consistently providing secondary (or better) treatment (Table III-16), meeting the conditions of NPDES permit KY0028002.

According to the Mammoth Cave Master Plan, the Conservation Center is slated to close before the year 2000. Therefore, further consideration of wastewater treatment at the facility is considered unnecessary.

## TABLE III-16
## GREAT ONYX JOB CORPS CENTER WASTEWATER TREATMENT PLANT

## PERFORMANCE DATA

| *Monthly Average NPDES Limit | BOD$_5$ (mg/l) | | Susp. Solids (mg/l) | |
|---|---|---|---|---|
| | 30 | | 30 | |
| | Inf. | Eff. | Inf. | Eff. |
| May 1977 | 140 | 28 | 146 | 28 |
| June | NO DISCHARGE | | | |
| July | 175 | 30 | 160 | 27 |
| August | 210 | 24 | 163 | 22 |
| September | 210 | 20 | 190 | 24 |
| October | 105 | 12 | 115 | 23 |
| November | 164 | 23 | 105 | 27 |
| December | 163 | 18 | 123 | 26 |
| January 1978 | 148 | 19 | 180 | 26 |
| February | 124 | 24 | 163 | 27 |
| March | 168 | 31 | 134 | 28 |

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*Grab Samples, one per month.

Source: NPDES Self-Monitoring Data.

## Small Wastewater Treatment Plants

There are eleven (11) small wastewater treatment plants located in the study area, most of them near the municipalities of Park City, Cave City and Munfordville. These facilities are identified in Table III-17 and their locations indicated in Figure III-5. However, no operating data are available for any of these wastewater treatment plants since monitoring programs are not yet established.

Of these eleven plants, nine have either direct or indirect discharges to groundwater. Five discharge directly to the sub-surface via sinkholes. Four discharge to lagoons with no outlet, but the water percolates into the ground. The impacts of these facilities on groundwater quality are unknown. Because of the nature of the wastewater, the relatively small flows and because there are no known water quality problems associated with such plants, it is presently assumed that impacts are minimal.

## Industrial Wastewater

There are only two significant sources of industrial wastewaters in the study area, the Hart County Creameries, Inc. (cheddar cheese, cheese by-products) and Ken Dec, Inc. (electroplating). Both industries are located in Horse Cave, Kentucky, and discharge process wastewaters to the Horse Cave municipal sewerage system. There is also a small slaughterhouse in Munfordville which discharges wastewater to the Munfordville system. However, even during peak months, daily flows average only 500 gallons per day. This represents only about 0.8% of the hydraulic loading and approximately 4% of the organic load (Eckenfelder, Water Quality Engineering), received by the Munfordville wastewater plant. Its impact is, therefore, considered negligible.

Sampling of Ken Dec wastewater indicates that proposed pretreatment standards for pH, CN, Cr , Cr , Cu, Zn and total metals are exceeded for these long-term composite samples. Composite samples do not, however, reflect the extreme variation in concentration of heavy metals as indicated by grab sample data. The fluctuation in concentrations cause shock loads at the municipal wastewater treatment plant. These are considered even more detrimental to biological processes than constant exposure to high concentrations of certain metals.

Ken Dec, Inc. has started operations of recently installed pretreatment facilities. If the new facilities operate as expected, wastewater is expected to be compatible with the biological wastewater treatment processes at the Horse Cave Municipal Plant.

Both Hart County Creameries, Inc. and Wheyco, Inc. are seasonal operations with greatest production in the summer months. The combined operations had a daily average water consumption of 37,180 gpd during the peak month in 1977, about 1.5 times the daily average consumption of 24, 564 gpd.

## TABLE III-17

## SMALL WASTEWATER TREATMENT PLANTS

| Facility | Location | County | Treatment | Design Capacity ($m^3$/day) | Discharge Type |
|---|---|---|---|---|---|
| Southern States Feed Mill | 31-W Cave City | Barren | Extended Aeration Chlorination | 1,500 gpd (6) | Lagoon |
| Park City Campground | Rt. 255 North of Park City | Barren | Extended Aeration Chlorination | 2,400 gpd (9) | Sinkhole |
| KOA Campground | Rt. 255 North of Park City | Barren | Extended Aeration Chlorination | 15,000 gpd (57) | Lagoon |
| Bon Ayr Toll Plaza | Jct. 252/Cumberland Parkway | Barren | Extended Aeration Chlorination | 1,500 gpd (6) | Green River |
| Crystal Onyx Cave | Rt. 90 South of Cave City | Barren | Extended Aeration Chlorination | 1,500 gpd (6) | Sinkhole |
| Park City School | Park City | Barren | Extended Aeration | 7,500 gpd (28) | Lagoon |
| Jellystone Park | Rt. 70 West of Cave City | Barren | Extended Aeration Chlorination | 20,000 gpd (76) | Lagoon |
| Park Mammoth Resort | 31-W West of Park City | Edmonson | Tertiary | 15,000 gpd (57) | Lagoon/Sinkholes |
| Snoball Dining Room | Mammoth Cave National Park | Edmonson | Secondary | - | Spray Irrigation |
| Caverna School | 31-W Cave City | Hart | Septic tank with intermittent sand filter | 10,000 gpd (38) | Sinkholes |
| Munfordville School | Jct. Rt. 818/U.S. 31-W Munfordville | Hart | Extended aeration with chlorination | 6,000 gpd (23) | Sinkholes |

Source: Kentucky Division of Water Quality, computer printout.

Equipment washdown accounts for nearly all water consumption at Hart County Creameries and Wheyco. In addition, it is estimated that approximately 90% of water consumption is discharged as wastewater to the Horse Cave sewerage system. This translates to an annual daily average wastewater discharge of about 23,600 gpd and a peak seasonal discharge of 39,600 gpd. Although the seasonal variations in wastewater flow are only a small percentage of hydraulic loading at the wastewater treatment plant, because of their high BOD's, the extra organic loading may significantly affect the treatment plant. In addition, they occur coincidentally with increased loadings due to summer tourist activities. Furthermore, since the largest volumes of wastewater are used at the end of a shift, most of the day's wastewater volume may be discharged within the span of a few hours. It is likely that some type of flow equalization will be required to prevent shock-loads to the Horse Cave wastewater treatment plant.

Ken-Dec pretreatment sludges are transported to another Ken-Dec plant in Ohio where they are containerized with wastes from that plant. They are then transported to a hazardous waste landfill in Indiana for final disposal.

## On-Lot Treatment Disposal Systems

Until recent years, the general method of wastewater disposal was to discharge untreated wastewater directly to openings in the rock, a practice which resulted in the potential pollution of groundwater due to the primarily cavernous limestone with free-flowing groundwaters. This practice is changing as septic tanks with absorption fields are presently installed with new construction. However, because of the soil/rock formations, septic tank effluents may drain directly to the groundwaters with little or no treatment in the soils.

Most of the on-lot systems are scattered throughout the rural areas of the region minimizing impacts on groundwater quality. However, the municipality of Park City constitutes a large source of untreated wastewater entering the groundwater system. Local health department officials indicate that about 80% of the residences and businesses in Park City discharge untreated wastewater directly to the subsurface, while the remaining 20% have septic tanks followed by direct discharge. Wastewaters from Park City have been traced to Echo River in Mammoth Cave and, although the overall effect of these discharges is undetermined since little is known about the assimilative capacity of underground streams, several instances of fecal contamination of individual domestic water supplies have been reported.

## Financial Programs

Sewer Rates - Sewer rates in the study area are all based upon a percentage of the users water bill. Sewer rates in the municipalities within the study area are determined as follows:

Horse Cave - 50% of Water Bill

Cave City - 80% of Water Bill

Mammoth Cave - 75% of Water Bill

Water rates schedules upon which the sewer rates are based are presented in the Water Supply Section.

Bonded Indebtedness - All of the municipalities have incurred bonded indebtedness in order to finance both water and sewer facilities. Table III-18 presents an outline of the existing sewer and water bonded indebtedness for each municipality in the study area.

## Wastewater Flow Projections

It is estimated that wastewater flows are 90% of the water consumption of study area populations. The only data available for any study area population are Cave City's water consumption and wastewater flow records for April-September, November and December, 1977. According to these data, wastewater flows averaged about 87% of water consumption by sewered customers. It is assumed that this 90% is not only applicable to the residential/commercial communities of Cave City, Park City and Munfordville, but is also useful in estimating industrial wastewater flows in Horse Cave and those associated with visitation in the National Park.

Infiltration/inflow was not considered in developing wastewater flow projections, due to a lack of flow data for existing wastewater treatment facilities and because infiltration/inflow work for the 201 study has not started. Infiltration/inflow, however, is not considered to be significant for preliminary design considerations in Cave City, Horse Cave or Mammoth Cave National Park. This is because process design is to be based on the peak seasonal organic loading which occurs during the summer months when infiltration/inflow is minimal.

Table III-19 indicates wastewater flow projections for each of the study area population centers. These flows represent the total wastewater generated by water consumption in each population center. They do not include allowance for I/I in sewered areas.

## Special Problem Areas

Non-point Sources of Pollution - Extensive agricultural activities in the study area, such as the use of fertilizers and pesticides or large scale livestock production, constitute a major potential non-point source of pollution. The greatest immediate pollution threat is the contamination of groundwater supplies, as wastes are carried into the groundwater through sinkholes, seepage through depressions or via sinking streams which drain agricultural areas.

## TABLE III-18 SUMMARY OF OUTSTANDING BOND ISSUES
JUNE 30, 1977

| Municipality | Purpose | Date | Original Issue | Rate of Interest | Maturity Date | Principal Outstanding |
|---|---|---|---|---|---|---|
| City of Horse Cave | Water and Sewer Revenue Bonds | 3/1/63 | $225,000 | 4.0000 | 3-1978/1979 | $ 20,000 |
| | | | | 4.1250 | 3-1980/1988 | 111,000 |
| | Water and Sewer Revenue Bonds | 3/1/63 | $546,000 | 4.0000 | 3-1978/1979 | 4,000 |
| | | | | 4.1250 | 3-1980/2003 | 526,000 |
| Total | | | $771,000 | | | $ 661,000 |
| City of Munfordville | Water and Sewer Revenue Bonds | 6/1/63 | $510,000 | 3.7500 | 6-1978/1981 | $ 38,000 |
| | | | | 4.0000 | 6-1982/1999 | 287,000 |
| | | | | 4.2500 | 6-2000/2003 | 104,000 |
| Total | | | $510,000 | | | $ 429,000 |
| City of Cave City | Water Revenue Bonds | 7/1/49 | $160,000 | 4.0000 | 7-1977/1984 | $ 55,000 |
| | Water and Sewer Revenue Bonds | 2/1/63 | $368,000 | 3.5000 | 2-1978/2003 | $ 349,000 |
| Total | | | $528,000 | | | $ 404,000 |
| City of Park City | Water Revenue Bonds | 4/16/73 | $200,000 | 5.0000 | 1-1978/2012 | $ 197,000 |
| Study Area Totals | | | $2,009,000 | | | $1,691,000 |

Source: Kentucky Local Debt. Report, Local Finance Office.
Department of Finance - Commonwealth of Kentucky

## TABLE III-19 WASTEWATER FLOW PROJECTIONS FOR STUDY AREA POPULATION CENTERS

| Municipality | Year | Estimated Population Served | Average Day mgd (m$^3$/day) | Peak Season Average Day mgd (m$^3$/day) | Maximum Day mgd (m$^3$/day) |
|---|---|---|---|---|---|
| Cave City | 1980 | 2,207 | .22(833) | .29 (1098) | .41(1552) |
| | 1990 | 2,440 | .24(908) | .33 (1249) | .46(1741) |
| | 2000 | 2,700 | .28(1060) | .37 (1400) | .52(1968) |
| Horse Cave | 1980 | 2,580 | .38(1438) | .40 (1514) | .56 (2120) |
| | 1990 | 2,960 | .38(1438) | .40 (1514) | .56 (2120) |
| | 2000 | 3,380 | .38(1438) | .41 (1552) | .57 (2158) |
| Park City | 1980 | 660 | .033(125) | .04 (151) | .06 (227) |
| | 1990 | 750 | .047(178) | .06 (227) | .08 (303) |
| | 2000 | 850 | .059(223) | .08 (303) | .11 (416) |
| Munfordville | 1980 | 1,700 | .09 (341) | NA | .2 (757) |
| | 1990 | 1,860 | .10 (378) | NA | .22 (833) |
| | 2000 | 2,040 | .12 (454) | NA | .25 (946) |
| Mammoth Cave National Park | | | | | |
| Total National Park Wastewater Flow | 1980 | NA | NA | .09 (341) | .14 (530) |
| Staging Area | 1990 | NA | NA | .069 (261) | .10 (378) |
| | 2000 | NA | NA | .08 (303) | .12 (454) |
| National Park Interims (concessions, camground and residential area) | 1990 | NA | NA | .04 (151) | .05 (189) |
| | 2000 | NA | NA | .04 (151) | .05 (189) |
| Total National Park Wastewater Flow | 1990 | NA | NA | .11 (416) | .15 (568) |
| | 2000 | NA | NA | .12 (454) | .17 (644) |

Source: Gannett Fleming Corddry and Carpenter, Inc.

Contamination from Oil Wells - Contamination of the Green River and groundwaters in the EIS study area during 1958-1960 was the result of waste brines improperly disposed of from oil production upstream of the study area. Chloride concentrations in the Green River at Munfordville averaged 3.9 mg/l prior to contamination and 257 mg/l after contamination (1958-1959) (Krieger and Hendrickson, 1960). Present (1978) chloride concentrations average 9.2 mg/l, which indicates that brine contamination in the Green River from oil wells upstream from Munfordville may no longer be a problem.

Within the EIS study area two sites of local oil well contamination have been documented. High sulfate contents measured in the Parker River Cave system are interpreted to be derived from oil wells (Table III-20).

TABLE III-20. SULFATE CONTENTS IN
PARKER RIVER CAVE SYSTEM

Sulfate Content mg/l

| Location | Quinlin | GFCC Sampling Moderate Flow | GFCC Sampling Low Flow |
|---|---|---|---|
| Brown River | 5 | 6 | - |
| Parker River | 250 | 128 | - |
| North Creek | 2 | 7 | 14 |
| Sulfur River | | | |
| Upstream Phantom | 44 | - | - |
| Phantom* | 2750 | - | 247 |
| Downstream Phantom | 660 | - | 246 |

*Site where water from local oil well leaks into the cave.

Sources: Quinlin, J.F. and D.R. Rowe, 1978 Research Report No. 109. University of Kentucky, Water Resources Research Institute

GFC&C, Inc. groundwater sampling program

Water samples from Mill Hole, the site to which Parker Cave streams flow, indicate little or no brine contamination (10 mg/l sulfate, 9 mg/l chloride), probably the result of dilution. Generally, water contamination from oil wells in the area is localized and not a serious problem.

The issue of these non-point waste sources is not whether these wastes should be controlled, but rather whether their impacts on water quality are great enough as to overshadow impacts of point sources. Some attempt to assess the impacts of agricultural runoff is necessary in order to help determine if improved treatment and disposal of point sources will result in significant water quality improvements.

## 9. WATER SUPPLY

There are three major sources of water supply in the study area: groundwater, groundwater springs and the Green River. Groundwater wells are used extensively for home water supplies in areas unserved by public supplies. In addition, groundwater is used for semi-public supplies such as camp grounds and motels. However, past experience (e.g. Park City) indicates that groundwater wells are generally not adequate for public and/or industrial water supplies. Because of the complexity of the groundwater regime, the quantity and quality of groundwater is unpredictable. The quality of groundwater may change drastically as it moves through certain subsurface formations and areas of chemical or biological contamination. Although there appear to be adequate groundwater supplies for home use, use of this type of water supply is expected to decrease as the public supply service area continues to expand into rural areas.

There are many locations on the Green River or tributaries where groundwater emerges from its subsurface drainage in free-flowing springs. Several of these provide large quantities of water year-round while others with smaller drainage areas flow only during wet-weather periods. These groundwater springs presently provide a source of water supply in Mammoth Cave National Park and the source of water supply for the Green River Valley Water District. According to the Mammoth Cave Master Plan, however, the National Park is slated to construct water treatment facilities to use the Green River as the supply. This decision was prompted by the heavy demands generated by park visitation resulting in lowering of the water level in the Caves, thus endangering cave biota. Rio Spring, near Caverna, Kentucky, serves as the source of water supply for the Green River Valley Water District. The Rio Spring provides water of good quality and an estimated minimum flow of 4 mgd.

The Green River serves as the water supply for the Edmonson County Water District (serving Park City). With a 7-day, 10 year low flow of about 209 cfs at Brownsville, the Green River appears to have sufficient yield to serve the entire study area. However, since the Green River Basin is largely an unprotected watershed, the supply is subject to pollution from runoff as well as point source discharges.

Table III-21 provides information regarding the source of water supply, average and maximum demands, service area description and treatment capacity for the three public water supply systems in the study area, Mammoth Cave National Park, Edmonson County Water District and the Green River Valley Water District. Each of the municipalities in the study area operates its own water distribution system (Table III-22).

### Water Consumption

Because of the influence of tourism in the study area, water consumption in the population centers of Horse Cave, Cave City and Park

TABLE III-21

PUBLIC WATER SUPPLIES IN STUDY AREA

| Water Supply | Source of Water | *Service Area | Approximate Number of Connections | (1977) Average Daily Pumpage (mg)($m^3$day) | (1977) Maximum Daily Pumpage (mg)($m^3$day) | Treatment Capacity (mg)($m^3$day) | Treatment | Future Planning |
|---|---|---|---|---|---|---|---|---|
| Green River Valley Water District | Rio Spring<br>Canmer, Kentucky | Rural areas of Barren and Hart Counties; supply to municipalities of Munfordville, Horse Cave, Cave City, and Hiseville | 3447 | 1.18<br>(4467) | 1.349<br>(5107) | 2<br>(7570) | Conventional | Green River Valley Water District is currently seeking funds to expand the treatment plant to 4 mgd. Presently adding about 600 new customers. |
| Edmonson County Water District | Green River<br>Brownsville, Kentucky | Rural areas of Edmonson County; Brownsville, Park City | 960 | 0.36<br>(1363) | 0.5<br>(189) | 0.5<br>(189) | Conventional | The Edmonson County Water District water treatment plant will be expanded to 1 mgd by May 1979 to accommodate an anticipated 800 additional customers. |
| | | | | National Park All system | | | | |
| | | | | 1973 Ave. Day For August | Estimated Maxi. Day | | | |
| Mammoth Cave National Park | | | | 0.418<br>(1582) | 0.65<br>(2461) | | | By the year 2000, use of existing sources of water will be discontinued. The Park master plan calls for treating water from the Green River to supply the needs of the Park. The treatment plant capacity is to be about 0.7 mgd. |
| A. Maple Springs System | Spring | Maple Springs Ranger Station | - | - | - | - | $Cl_2$ | |
| B. Great Onyx Job Corps Center System | Cooper Springs<br>Collins Springs | Job Corps Center Facilities | - | - | - | - | $Cl_2$ | |
| C. Mt. McKinley System | Cooper Springs<br>Collins Springs | Southeastern section of National Park | - | - | - | - | $Cl_2$ | |
| D. Flint Ridge System | Bransford Springs<br>Bransford Well<br>Adwell Springs | Park Headquarters area and main cave entrance facilities | - | - | - | - | $Cl_2$ | |

Source: Comprehensive Water and Sewer Plan
personal communication, Green River Valley Water District
personal communication, Edmonson County Water District
Mammoth Cave National Park Master Plan

## TABLE III-22

## MUNICIPAL AND NATIONAL PARK WATER SYSTEMS

| Water System | Water Supply | Service Area | Approximate # Connections | 1977 Average Daily Pumpage (m$^3$/day) | Average Daily Pumpage During Peak Month (m$^3$/day) | *Estimated Maximum DailyPumpage (m$^3$/day) |
|---|---|---|---|---|---|---|
| Horse Cave | Green River Valley Water District | Horse Cave Limits | 824 | 0.412 mg<br>(1560) | 0.461 mg<br>(1745) | .64<br>(2422) |
| Munfordville | Green River Valley Water District | Munfordville Area | 612 | 0.15<br>(568) | N/A | .24<br>(908) |
| Cave City | Green River Valley Water District | Cave City Limits | 714 | 0.29<br>(1098) | 0.375<br>(1420) | .52<br>(1968) |
| Park City | Edmonson County Water District | Park City Limits | 225 | **0.045<br>(170) | **0.06<br>(227) | .084<br>(318) |
| Mammoth Cave National Park | Green River Valley Water District | National Park Facilities and Concessions | - | ***0.049<br>(185) | *** .101<br>(382) | 0.141<br>(534) |

* Since daily flow records are not available, estimated maximum day = (July - August 1977 Average Day) x 1.4

** Estimates due to leaks in the system.

*** Estimates based on 1975 park water use since several meters have been out of service recently.

Source: BRADD Comprehensive Water and Sewer

BRADD 1978 Data Book

Water Billing Records; Cave City, Park City, Munfordville

Mammoth Cave National Park Water Use Records and personal communications w/Mr. Wally Hartz of the Park's Staff

City fluctuates significantly during the year. Seasonal variation, however, is not as evident in Horse Cave due to large industrial consumption. Munfordville is not significantly affected by tourism.

Water consumption projections for each municipality are developed by estimating the following components of consumption:

1. Residential consumption

2. Commercial consumption associated with tourism (Cave City, Park City and Horse Cave)

3. Commercial consumption not associated with tourism

4. Industrial consumption (Horse Cave only)

For design purposes the average daily demand during the peak month of the tourist season and maximum daily demand are considered to be most important. Because Horse Cave, Cave City and Park City are affected most by non-resident population, a method of estimating commercial consumption associated with tourist demand for those communities was developed. Peak seasonal consumption is based on these calculations and projected increases in Mammoth Cave National Park visitation. Maximum daily consumption is developed by multiplying the average consumption during the peak month by a factor of 1.4. This reflects the approximate maximum/average ratio in park visitation during the peak season and also a typical maximum to average ratio for small water systems. Water consumption projections for each municipality are found in Table III-23.

Water consumption projections for Mammoth Cave National Park appear in Table III-24. For the purposes of projecting consumption, it is assumed that the staging area is constructed between 1980 and 1990.

## 10. COMMUNITY SERVICES AND FACILITIES

Community services and facilities in the study area have been surveyed to determine their current level of services and their ability to serve the existing population. These services and facilities can either be affected by wastewater facilities planning through increases in population as a result of greater wastewater capacity or some of the services can, in fact, impact the planning of wastewater facilities. This inventory will review the major community services and facilities which are provided in the study area. These include: health services; public safety (police and fire protection); sanitation; education and libraries and tax structure.

## TABLE III-23 WATER CONSUMPTION PROJECTIONS FOR MUNICIPAL POPULATION CENTERS

| Municipality | Year | Estimated Population Served | Average Day mgd ($m^3$/day) | Peak Season Average Day mgd ($m^3$/day) | Maximum Day mgd ($m^3$/day) |
|---|---|---|---|---|---|
| Cave City | 1980 | 2,207 | .24(908) | .32(1211) | .45(1703) |
| | 1990 | 2,440 | .27(1032) | .37(1400) | .51(1930) |
| | 2000 | 2,700 | .31(1173) | .41(1552) | .58(2195) |
| Horse Cave | 1980 | 2,580 | .42(1590) | .45(1703) | .63(2384) |
| | 1990 | 2,960 | .42(1590) | .45(1703) | .64(2422) |
| | 2000 | 3,380 | .42(1590) | .46(1741) | .65(2460) |
| Park City | 1980 | 660 | .037(140) | .045(170) | .063(238) |
| | 1990 | 750 | .052(196) | .065(246) | .091(344) |
| | 2000 | 850 | .066(250) | .086(326) | .12 (454) |
| Munfordville | 1980 | 1,700 | .10(379) | NA | .14(530) |
| | 1990 | 1,860 | .11(416) | NA | .16(606) |
| | 2000 | 2,040 | .13(492) | NA | .18(681) |

Source: Gannett Fleming Corddry and Carpenter, Inc.

## TABLE III-24. WATER CONSUMPTION PROJECTIONS FOR MAMMOTH CAVE NATIONAL PARK FOR THE PEAK MONTH OF THE TOURIST SEASON

| | (1) Park Concessions | | (2) Campground | | (3) Residential Area | | (4) Visitors Center | | (5) Total Consumption | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Average mgd ($m^3$/day) | Maximum mgd ($m^3$/day) | Average mgd ($m^3$/day) | Maximum mgd ($m^3$/day) | Average mgd ($m^3$/day) | Maximum mgd ($m^3$/day) | Average mgd ($m^3$/day) | Maximum mgd ($m^3$/day) | Average mgd ($m^3$/day) | Maximum mgd ($m^3$/day) |
| *1980 | .031<br>(117) | .046<br>(174) | .006<br>(23) | .01<br>(38) | .002<br>(8) | .003<br>(11) | .062<br>(235) | .092<br>(348) | .10<br>(379) | .15<br>(568) |
| 1990 | .035<br>(132) | .046<br>(174) | .007<br>(26) | .01<br>(38) | .002<br>(8) | .003<br>(11) | **.077<br>(291) | **.11<br>(416) | .12<br>(454) | .17<br>(644) |
| 2000 | .039<br>(148) | .046<br>(174) | .008<br>(30) | .01<br>(38) | .002<br>(8) | .003<br>(11) | **.09<br>(341) | **.13<br>(492) | .14<br>(530) | .19<br>(719) |

* Estimated to be approximately the same as 1970 maximum month, assuming 20% loss in water distribution system.

** Since the expected construction date of the staging area Visitor's Center is the mid 1980's, 1990 and 2000 projected consumptions are assumed to occur at the new site.

Source: Gannett Fleming Corddry and Carpenter, Inc.

## Health Services

Table III-25 identifies health care facilities and manpower serving the three county study area.

## Public Safety

Fire Protection - Fire protection services in the study area are provided by volunteer fire departments located within the individual municipalities. Edmonson County maintains a county fire department but the other counties of Hart and Barren do not. The fire departments in Horse Cave and Munfordville have 4 and 5 pieces of equipment, respectively. There is no information available on the fire departments in Cave City or Park City.

Police Protection - Each county has a police department with a sheriff who is the principal law enforcement officer. Barren County has four police officers, Edmonson County has three, and Hart County has four. Each of the municipalities in the study area also has their own police department. Cave City has four police officers, Park City one, Horse Cave three, and Munfordville two police officers.

## Sanitation

| Area | Solid Waste Services |
|---|---|
| Barren | |
| Cave City | Private collection/approved landfill |
| Park City | Private collection/approved landfill |
| Other rural areas | No private collection available |
| Edmonson (half) | Private collection/approved landfill in Grayson County |
| Hart | |
| Munfordville | Private collection/approved landfill |
| Bonnieville | Private collection/approved landfill |
| Portions of rural Hart County | Private collection/approved landfill |

## Tax Structure

Property taxes provide the major source of income for state, county and local governments. Land and buildings are taxed by the state and may be taxed by local jurisdictions. The state rate is $0.015 per $100 of assessed valuation. Tangible personal property such as automobiles, trucks, finished goods, office furniture and

## TABLE III-25
## HEALTH CARE FACILITIES AND MANPOWER

| County | Facility | Capacity |
|---|---|---|
| Barren | T.J. Samson Hospital, Glasgow | 199 beds |
| | Intermediate Care Nursing Home | 52 beds |
| | Two personal care homes | 98 beds |
| | One home | 20 extended care beds |
| | County health department | - |
| Hart | Caverna Memorial Hospital, Horse Cave | 30 beds |
| | Personal care home | 54 beds |
| | County health department | - |
| Edmonson | One personal care home | 37 beds |
| | County health department | - |

| County | Physicians | Dentists | Nurses | Optometrists | Pharmacists |
|---|---|---|---|---|---|
| Barren | 31 | 9 | 187 | 4 | 28 |
| Edmonson | 2 | 1 | 8 | - | 1 |
| Hart | 13 | 3 | 36 | 2 | 8 |
| TOTAL | 46 | 13 | 231 | 6 | 37 |

Sources: BRADD Data Book, 1978.

GFC&C, Inc.

office equipment which are owned by manufacturers are also taxed by the state at $0.15 per $100 and may be taxed by local jurisdictions.

Table III-26 provides the local property tax rates per $100 of assessed valuation by the various taxing jurisdictions in the study area.

### Utilities

The study area is serviced by a variety of utility companies who provide electric, natural gas and telephone service. Table III-27 outlines the provision of these services in the study area.

## 11. OTHER PROJECTS AND PROGRAMS

Beyond the preparation of the 201 Wastewater Facilities Plan and the Wastewater Facilities Environmental Impact Statement, the following is an outline of projects and programs in the study area which are relevant to wastewater facilities planning and water quality management.

### Green River Basin 303(e) Plan

This is a basin wide plan prepared to comply with the Federal Water Pollution Control Act Amendments of 1972. The plan establishes the following:

- Existing water quality, specifying applicable standards for water quality.
- An analysis of planning programs conducted by Federal, state, regional and local agencies throughout the Green River Basin.
- Compliance schedules and target dates for the abatement of pollution from point sources and non-point sources.
- Specific needs and priorities for the construction of municipal wastewater treatment plants in the Green River Basin.

### Comprehensive Water and Sewer Plan for the Barren River Area Development District

This is a regional plan for water and sewer facilities in the BRADD region. The plan, which was completed in 1979, identifies six major goals for the improvement of water distribution and wastewater disposal systems in the BRADD region, water and wastewater disposal

## TABLE III-26
## LOCAL PROPERTY TAX RATE PER $100 OF ASSESSED VALUATION, 1975

| Taxing Jurisdiction | Barren County | Cave City | Hart County | Horse Cave | Munfordville | Edmonson County |
|---|---|---|---|---|---|---|
| County | $ .149 | $ .149 | $ .159 | $ .159 | $ .159 | $ .143 |
| School | $ .427 | $ .903 | $ .502 | $ .903 | $ .502 | $ .368 |
| City | --- | $ .1875 | --- | $ .230 | $ .40 | --- |
| Special (not county wide) | | | | | | |
| Fire Protection | | | | | | $ .02 |
| Watershed | | | | | | $ .10 |
| Watershed Flood Plain | | | | | | $1.00 per acre |

Source: Industrial Resources, Kentucky Department of Commerce, 1976

## TABLE III-27
## UTILITY COMPANIES IN THE STUDY AREA

| Municipality | Electric | Natural Gas | Telephone |
|---|---|---|---|
| Barren County | Kentucky Utilities Company<br>Farmers Rural Electric Cooperative Corporation<br>Warren Rural Electric Cooperative Corporation | Western Kentucky Gas Co. | South Central Rural Telephone Cooperative |
| Cave City | Kentucky Utilities Company | Western Kentucky Gas Co. | South Central Rural Telephone Cooperative |
| Hart County | Farmers Rural Electric Cooperative Corporation | Western Kentucky Gas Co. | South Central Rural Telephone Cooperative |
| Horse Cave | Kentucky Utilities Company | Western Kentucky Gas Co. | South Central Rural Telephone Cooperative |
| Munfordville | Kentucky Utilities Company | Western Kentucky Gas Co. | South Central Rural Telephone Cooperative |
| Edmonson County | Warren Rural Electric Cooperative Cooperation<br>Farmers Rural Electric Cooperative Corporation | No natural Gas service | Kentucky Telephone Co. |

Source: Industrial Resources, Kentucky Department of Commerce, 1976 systems problem areas, and recommendations for the resolution of each problem.

### Mammoth Cave National Park Master Plan

This plan, completed in April, 1975, was prepared because of increasing travel in the park, changing public needs, and studies required by the Wilderness Act. These needs and requirements have necessitated a complete review of the park's development and management, resources management and visitor usage. A major concern of the plan is preserving the environmental quality of the park while attempting to handle increasing park visitations. An environmental impact statement was also prepared in conjunction with the park's master plan.

### Mammoth Cave National Park Transportation Study

This study, which is currently under way, is carrying out a directive of the master plan, namely the development of a transportation plan for the park. The plan is intended to alleviate congestion in the park, and to determine transportation routes from the proposed staging area to the cave sites. In conjunction with this study, detailed visitation projections are being developed. This study should be completed by Spring, 1981.

## PART D. ENVIRONMENTAL IMPACTS OF ALTERNATIVES

This part identifies the major impacts of all the alternatives, including the no-action alternative, on the natural and man-made environment. Impacts of the proposed alternative or strategy are discussed and compared with the impacts of the other alternatives.

Since the alternatives primarily address existing problems, as opposed to future growth, impacts are primarily direct in nature and are associated with construction and operation activities. However the indirect impacts associated with secondary development could have serious impacts on several environmental parameters particularly in the Mammoth Cave National Park area.

## 1. IMPACTS ON THE NATURAL ENVIRONMENT

### Introduction

Natural environment refers to the land and water resources of the study area along with the area's wildlife. The purpose of this section is to assess the impacts of wastewater facilities upon the natural environment of the study area. Impacts are generally assessed on a short term and long term basis. In the case of wastewater facilities, most short-term impacts will arise from the construction of facilities. Long term impacts will arise from operations plus the type of effluent discharge which is selected.

### Climate

The study area has a variable continental climate with wide extremes in temperature but precipitation is well distributed throughout the year. The prevailing wind direction is from south to southwest. The no-action alternative has no significant impact on the climate of the study area.

Treatment alternative 7 disposes of treated effluent from Cave City with a spray irrigation land application system during the dry season. Land application systems may cause a limited localized temperature reduction. There is no detectable difference in impacts when comparing the remaining alternatives and none of these alternatives has a significant impact on the area's climate. Therefore, the preferred alternative is not expected to significantly impact the study area's climate.

### Air Quality

There are no significant pollution problems primarily due to the rural nature of the area. Air quality is negatively impacted by temporary increases in dust and exhaust emissions from vehicular traffic associated with construction and operation and maintenance of wastewater treatment and conveyance facilities. An increase in the number of treatment plants may increase emissions of aerosols, particulates and gases from these plants. Increases in development permitted by an increase in treatment capacity may also increase exhaust emissions from vehicles. The no-action alternative does not involve construction or a change in the present number of level of operation and maintenance at wastewater treatment facilities. This alternative could also restrict industrial, commercial and residential development once present treatment plant capacity is approached. Therefore the no-action alternative does not have a significant impact on air quality.

Short term negative impacts to air quality are generally directly proportionate to the distance of pipeline construction. The proposed wastewater treatment alternatives are ranked as follows from shortest to longest distance of pipeline: Alternatives 8, 5, 6, 7, 3, 4, and 2. These alternatives permit growth in the study area with associated increases in vehicular traffic. The preferred alternative is a phased approach, beginning with a variation on Alternative 5. This alternative calls for the next to the least amount of pipeline construction and is, therefore, not expected to create any significant adverse impacts to air quality. However, if the NPS decides to participate, then the second phase is essentially Alternative 2, which has the greatest amount of pipeline construction and could, in fact, cause relatively significant short term impacts to the air quality of the region.

Alternative 7 disposes of treated effluent from Cave City with a spray irrigation land application system during the dry months. Land application systems may negatively impact air quality by increasing aerosol formation with pathogen transmission from the spray systems. Alternatives 5 and 8 are the only alternatives that do not include additional wastewater treatment facilities at either Park City or Chaumont. These facilities could have a slight negative impact on air quality at these sites. The first phase of the preferred alternative does not include construction of additional treatment facilities at Park City or Chaumont, and therefore this alternative would not negatively impact air quality as a result of operation of the newly constructed facilities. However, the second phase of the preferred approach, does call for construction of facilities and could, due to operation of the facilities, potentially impact air quality. However, none of the proposed alternatives has a significant impact on air quality in the study area.

## Odor

Currently, there are odor problems in the Horse Cave and Park City areas related to malfunctioning of the present treatment facilities and septic systems, respectively. These odor problems are likely to persist under the no-action alternative due to financial constraints for facilities improvement. However, operational changes associated with efforts to meet permit levels is likely to lessen existing odor problems. The number of on-lot treatment systems and the possibility of their malfunction may actually increase with this alternative.

All proposed wastewater treatment alternatives eliminate the odor sources at Horse Cave and Park City; therefore, there is no detectable difference in impacts between the alternatives on this basis. All of the alternatives including the preferred alternative will have significant beneficial impacts on odor problems for these sites.

Alternative 7 disposes of Cave City treatment facility effluent with a land application system during the dry months. Odors may be caused by anaerobic conditions at the site or in the effluent. Alternatives 3, 5, 6, and 8 have composting waterless toilets at the Staging Area. These systems have potential for odor problems if the wastes are not composted properly. All proposed alternatives except alternatives 5 and 8 include additional treatment facilities at either Park City or Chaumont. The new facilities proposed in Alternatives 1, 2, 3, 4, 6 and 7 may cause local odor problems if not maintained properly. The preferred alternative should not cause any significant odor problems. In fact, the removal of wastewater from Hidden River Cave will correct the worst odor problem in the area.

## Topography

Wastewater treatment projects rarely have topographic impacts. Construction can have a significant negative impact on topography. The no-action alternative does not involve any construction in the study area and has no impact on the topography.

Pipeline construction follows existing road right-of-ways or gently rolling agricultural land and has slight topographic impact. Most slight topographic changes caused by construction can be returned to their original conditions. Treatment alternatives involving the least amount of construction have the least chance of impact and the alternatives are ranked from least pipeline construction to most as follows: 8, 5, 6, 7, 3, 4, and 1-2. The first phase of the preferred approach requires the next to the least amount of pipeline construction, thereby lessening the chance of significant impact on topography. The second phase requires the greatest amount of pipeline construction, and therefore could have the greatest impact on topography.

Treatment facility construction also has potential topographic impact and all of the treatment alternatives involve facility construction. However, this construction is on gently rolling agricultural land and has slight impacts. None of the construction required in these alternatives has a significant impact on the area's topography.

## Geology

The karstic nature of the study area represents a relatively complex geologic setting. Moderate geologic impacts may be associated with pipeline and facility construction due primarily to blasting. Impacts could also result from ponding of soil absorption systems. This ponding could cause premature sinkhole formation. The no-action alternative involves no construction or additional soil system absorption systems and therefore has no impact on geology of the study area.

Alternatives that involve less facility or pipeline construction have less potential impact. Alternative 8 involves the least construction and Alternatives 1 and 2 involve the most. Remaining alternatives ranked from least to most construction are 5, 6, 7, 3, and 4. The first phase of the preferred alternative involves the next to the least amount of construction and is expected to have little potential impact on geology. The second phase, however, requires the most construction, and therefore, has a greater potential for negative impact to geology. Community soil absorption fields are involved in alternatives 4, 5, 7, and 8. This includes the first phase of the preferred alternative. Soil absorption fields are scheduled for the Staging Area in alternatives 6 and 8. These systems have potential negative geologic impact if ponding occurs. None of the proposed alternatives has a highly significant adverse impact on area geology.

## Soils

There are nine soil associations in the study area. Soil characteristics such as depth, moisture content and location are dependent in large part on the regional topography. The no-action alternative would involve continued and increased use of on-lot systems in areas where regional treatment facilities would not be available. The potential exists for soils in these areas to become clogged from improperly designed, installed or constructed systems. Additionally alternatives 3 through 8 involve on-lot systems, and the potential exists for similar impacts to occur at these sites.

None of the alternatives involve removal or transport of large amounts of soil so construction of facilities and pipelines will not significantly impact the soil system. In that respect there are not any detectable differences in impact between alternatives. However, alternative 7 uses land application of treated effluent from Cave City treatment facility during the dry months. Soil drainage characteristics and levels of chemical constituents may be affected by land application. This could be a moderate adverse impact in a localized area. The impacts of the alternatives, including the preferred alternative, on soil conditions in the area are not highly significant.

## Noise

The study area has relatively low ambient noise levels. Short term noise impacts are generally with pipeline and facility construction and are caused by movement of heavy equipment, possibly blasting, and ditch digging. Facility operation and maintenance noise includes operation of mechanical aerators and some increase in vehicular traffic. The no-action alternative does not involve construction or increased operation noise and therefore has no significant impact.

Assuming construction noise is generally proportional to distance of pipeline construction, treatment alternatives are ranked as follows from least to greatest impact: alternative 8, 5, 6, 7, 3, 4, and 1-2. Therefore, the first phase of the preferred alternative should have little noise impact on the study area. The second phase, however, should have the greatest amount of noise impact associated with construction. Slight long term impacts on noise are associated with construction and operation of additional treatment facilities located at Park City or Chaumont with all alternatives except 5 and 8. Noise impacts associated with any of the proposed alternatives are either short term or localized low levels and are not significant to the study area.

### Subsurface Water Resources

The karst nature of the study area produces a marked dominance of groundwater drainage over surface water drainage. There is a wide variation in free-flowing groundwater quantity in response to rainfall events. The karst nature of the topography and rapid infiltration rates are conditions which leave the subsurface water resources highly susceptible to pollution by surface activities. While most residences do not utilize this resource as a drinking water supply, the subsurface waters are used for agricultural activity and some residential use.

The major area groundwater pollution problem is associated with the effluent discharges from wastewater treatment facilities at Horse Cave and Cave City. Impacts can be assumed to be occurring from faulty on-lot systems throughout the study area and particularly at Park City. Other surface activities which can seriously impact the subsurface water resources include: storage tank leaks, dumping and spill incidents, transportation accidents, leachate from old well sites and nonpoint source runoff.

The no-action alternative would not remove or substantially improve the existing disposal activity. Major, long term, detrimental impacts to the subsurface resources could be expected to continue despite efforts to improve plant operation. Major plant improvements would be constrained by limited available funding.

All other waste management alternatives would include the transfer of the Horse Cave treatment plant discharge from the existing subsurface discharge point to the Green River. This would be a major environmental benefit to the subsurface water resource. Alternatives which would also include the Cave City effluent being discharged to the Green River (1, 2, 3, 4, 5) would provide additional protection to the groundwater resource. This includes both phases of the preferred alternative. Alternative 7 proposes seasonal subsurface discharges at Cave City. While the upgrading of facilities and seasonal land disposal of effluent would be an improvement over existing conditions, the improvement would be as great as with the discharge going to the Green River. Alternatives 6 and 8 propose continued subsurface discharge of Cave City's wastewater. Although the treatment facility would be upgraded, the continued discharge would be expected to result in long term degradation of the subsurface water quality. All alternatives except the no-action alternative would provide for an improvement in the wastewater treatment practices at Park City. However, alternative 1 and the second phase of the preferred alternative would include a regional system and discharge to the Green River, providing potential for the maximum improvement and protection of the subsurface resources from wastewater influences. The second phase of the preferred alternative in particular would protect subsurface resources in the National Park from wastewater systems in Park City and along Route 70. However, in order to realize the potential protection of this alternative, local development and land use restrictions would need to be implemented. Potential threats to the park system could include non-point source runoff and leakage from fuel storage tanks associated with potential growth and development along Rt. 70 and in Park City that could offset water quality improvements achieved through improved wastewater management. In addition, groundwater could be impacted by the use of soil absorption fields for municipal wastewater or greywater as in alternatives 3, 4, 6, 7, and 8 and Phase 1 of the preferred alternative or spray irrigation land application systems (alternative 7). However, with proper installation, operation and maintenance these practices should not have significant adverse impacts.

Due to the karstic nature of the study area, pipeline leaks can have major impacts on the subsurface water resource. The potential for pipeline leaks or breaks can be assumed to increase with the pipeline distance. The alternatives with greater pipeline distances would have greater potential for negative impacts to water quality. Alternative 8 would have the least potential in this regard and Phase 2 of the preferred approach would have the greatest potential. The degree of negative impact would be higher with lines which carry untreated wastewater as opposed to treated effluent. Phase 2 of the preferred approach would have the longest pipeline for raw wastewater and therefore the greatest risk in this regard. Extensive effort would be required to provide adequate protection to the subsurface resources during the design and construction activities.

Overall, a major beneficial impact to the subsurface resources is associated with those alternatives that remove all wastewater from the subsurface, with decreasing benefit attached to those that involve continued or increased subsurface discharges.

## Surface Water Resources

The major surface water resource in the study area is the Green River. Few other surface streams exist in the area due to the hydrologic conditions associated with the karst geology. Surface streams originating from the uplands flow north toward the Green River and sink along the south and east margins of the sinkhole plain.

The existing water quality in the Green River is generally considered to be good. The river is presently not used for drinking water within the study area but the Mammoth Cave National Park Master Plan outlines plans to use it as a water source in the future.

The Green River has a large assimilative capacity. The minimum 7-day, ten year low flow is estimated at 159 cfs and neither development or discharges upstream of the study area are extensive. Currently both Munfordville and Mammoth Cave National Park discharge wastewater effluent to the Green River. Munfordville has a design effluent discharge of 0.15 mgd while the Park has a highly variable discharge dependent upon user level with a design capacity of 0.12 mgd. The Great Onyx Civilian Conservation Center in the Park has a design flow of 0.02 mgd. The much diluted subsurface effluent discharges of Horse Cave and Cave City currently flow into the Green River in the area of Lawler Bend through approximately 15 springs.

The no-action alternative would not have significant impacts on existing surface water quality. Subsurface discharges at Horse Cave and Cave City would continue. However, effluent quality might be improved through pre-treatment requirements and enforcement, improved treatment plant operating procedures and treatment efficiency.

All other alternatives would include Horse Cave Treatment Plant effluent being discharged to the Green River. Alternatives 1, 3, 4, and both phases of the preferred alternative would also provide for effluent discharge from the Cave City treatment plant to the Green River. The major impacts to surface water quality would be associated with the construction of this pipeline and outfall and the long-term discharge of effluent. Construction activities could produce major sediment loads in the Green River. This short-term impact would have greater implications on aquatic organisms than water quality. Sediment could be transported as far as the pool area of Lock 6 within the Park but would probably settle out before that point. Coffer Dam construction for the outfall system would involve the building of a dirt peninsula into the river, the digging of the pipeline trench, the pumping of sediment laden water from the trench and the removal of the construction peninsula. Erosion and sediment transport from this activity could be highly significant unless mitigative measures were enacted.

Maximum capacity of the treatment plants under the regional system (Phase 2 of the preferred approach) would be 1.1 mgd. The dilution factor based on low flow information for the Green River (7Q10 = 250 cfs) and maximum effluent flow (1.1 MGD) is approximately 160:1. Effluent characteristics should be secondary treatment levels (BOD - 30 mg/l, suspended solids - 30 mg/l) and should not have major impacts on the existing water quality. It would be necessary however to improve treatment plant reliability, insure industrial pretreatment and control industrial discharges in case of pretreatment failure. Additional consideration would be required in the design of the disinfection systems at the treatment plants. If chlorination were included as the disinfection method, system design would need to consider the possible toxic effects of chlorine on stream biota. Chlorination effects should be minimal due to the extended transit time required to cover the distance to the Green River discharge point from the Horse Cave STP.

## Cave Ecology

Caves are numerous in the study area and constitute a significant resource. These cave systems are some of the most intensely studied in the world and support extensive biotic communities compared to other caves. Energy to support these communities comes primarily from sources outside the cave. Therefore, surface activities have significant impacts on cave energy pathways and ecology.

Externally derived impacts on caves are summarized in Table III-28. Actions listed in the table which are particularly germane to this EIS are: Pollution--water; Hydrological Modification--surface construction and siltation; and vibration and noise--blasting.

Significant negative impacts on the Hidden River system presently result from direct discharge of effluents from wastewater treatment facilities at Cave City and Horse Cave. Faulty septic systems in the Park City area have direct impacts on local cave systems. The no-action alternative would not alter present treatment practices in the area.

All Alternatives would prevent municipal and industrial wastes from entering the Hidden River Cave system from Horse Cave. All alternatives except 6, 7 (during the wet season) and 8, (includes the preferred alternative) would remove Cave City's municipal discharge from this system also. In addition, all alternatives would provide reduced dependence on faulty septic systems in the Park City area. These proposed actions would have a significant beneficial impact on cave ecology.

Soil absorption units at Park City or the Staging Area (alternatives 3, 4, 6, 7, 8 and the first phase of the preferred approach) and a land application system for Cave City municipal effluent (alternative 7) would have potential negative impacts on cave ecology through groundwater degradation unless the systems were properly designed, installed, operated and maintained. Alternatives 6 and 8 would provide for the continued discharge of Cave City's wastewater into the Hidden River Cave System and alternative 7 would do so on a seasonal basis. These practices would adversely affect subsurface water quality and in turn cave ecology.

The length of pipeline for prepared alternatives would affect caves in two ways. The more pipeline construction involved, the greater the potential damage to the caves by blasting. Phase 2 of the preferred approach would provide for the greatest amount of pipeline construction and could potentially have the greatest amount of adverse impact to the cave systems. Alternative 8 has the least amount of construction and Phase 1 of the preferred alternative has the next to the least amount. Increasing the amount of pipe laid also would increase the potential for pipeline breaks or leaks.

Negative impacts of the caves from pipeline leakage would be greater for raw sewage than for treated effluent. Alternatives 1, 2, 4, and 7 would include transport of raw sewage along part of the pipeline system. In sensitive areas such as these extraordinary design measures would have to be taken to avoid such negative impacts.

TABLE III-28 EXTERNALLY DERIVED IMPACTS ON CAVES

| Action | Source | Cave Area Affected [1] | Nature of Impacts | Incidence [2] | | | Irreversible-Irretrievable [3] |
|---|---|---|---|---|---|---|---|
| | | | | Time | Space | Degree | |
| 1. Pollution | | | | | | | |
| A. Water | | | | | | | |
| 1. Municipal Wastes | city sewage systems, or lack thereof | P | water polluted,odor & methane gas, affects ecosystem | L | LR | V | N-M |
| 2. Industrial Wastes | factories, thru streams or direct seepage | PA | water polluted,odor & methane gas, heavy metals and affects ecosystem | SL | LR | V | N-M |
| 3. Septic Tanks | homes, some small industrial | P | water polluted,odor & methane gas,highB.O.D., nutrients; affects ecosystem | M | LW | H | N-M |
| 4. Agricultural Runoff | farm and pasture lands | P | siltation,pollution,odor & methane gas,upsets ecosystem, destroys lifeforms,increases nutrients,decreased D.O. | L | LW | M | Y-Y |
| 5. Urban Runoff | city streets, parking lots | P | petroleum poisoning, siltation, upsets ecosystem | L | L | H | N-Y |
| 6. Sinkhole Dumps<br>Other Dumps<br>Landfills | improper waste disposal | P | Water pollution remote and local | V | LR | M | N-Y |
| 7. Gasoline Spills<br>Toxic Compound Spills<br>Pipeline Leakage | gasoline & chemical storage facilities, filling stations, parking lots,streets highways & pipelines | A | explosion hazard,destroys ecosystem, may damage formations | S | L | H | Y-Y |
| 8. Sinking Polluted Streams | surface pollution sources | P | siltation,pollution,upsets ecosystem | V | L | M | N-Y |
| 9. Thermal Pollution | power plants | PA | changes cave climate,upsets ecosystem | S | L | M | N-M |

TABLE III-8 EXTERNALLY DEIRVED IMPACTS ON CAVES (Cont'd.)

| Action | Source | Cave Area 1 Affected | Nature of Impacts | Incidence 2 Time | Incidence 2 Space | Incidence 2 Degree | Irreversible- Irretrievable |
|---|---|---|---|---|---|---|---|
| 10. Stream Tracing | technical | P | no known adverse effects when properly used;high beneficial impact when used for identifying sources of pollution | S | L | L | N-N |
| B. Air | | | | | | | |
| 1. Surface Air Pollutants | cars,factories | A | increases solution rate of carbonate rocks | L | U | L | N-Y |
| 2. Smoke | fires on surface, cigarettes | V | air particulate matter, deposition of film on , surface of formation | S | L | L | N-Y |
| 3. Inflammable Gases | gas pipelines, vegetation decay | V | potential explosion hazard | L | L | L | N-N |
| 4. Airborne Herbicides and Pesticides | crop spraying | A | destroys ecosystem | L | L | M | N-Y |
| 2. Hydrological Modification | | | | | | | |
| A. Surface Construction | | | | | | | |
| 1. Roads | population proximity | A | diverts water sources,changes water source locations, dries out cave, destroys ecosystems, pollution(see above) | L | L | M | N-Y |
| 2. Parking Lots | population proximity | A | stops infiltration, dries out rocks,destroys ecosystem, pollution,may cause rock falls | L | L | H | N-Y |
| 3. Buildings | population proximity | A | stops infiltration,dries out cave,interupts water flow | L | L | L | N-Y |
| 4. Stripping Topsoils | land leveling, recreational development | A | flooding, siltation | S | L | H | Y-Y |

TABLE III-28 EXTERNALLY DERIVED IMPACTS ON CAVES (Cont'd.)

| Action | Source | Cave Area 1 Affected | Nature Of Impacts | Incidence 2 | | | Irreversible-3 Irretrievable |
|---|---|---|---|---|---|---|---|
| | | | | Time | Space | Degree | |
| 5. Agricultural | farming operations | A | siltation, infiltration changes, flooding, pollution | L | LW | H | N-Y |
| B. Water Projects | | | | | | | |
| 1. Dams | need for flood control, power, and recreation | A | water level raised, inundation, increased recreational use | L | L | H | N-M |
| 2, Channelization | drainage, flood control | A | water level lowered, flooding decreased, may affect ecosystem | L | L | H | Y-Y |
| 3. Pumping of Groundwater | farming and ranching | P | water level lowered, possible collapse, increased siltation | D | LW | H | N-M |
| 4. Capping Springs | need for water | A | reduction in water flow, upsets ecosystem | D | L | M | N-M |
| C. Deforestation | conversion from forest to other land use | A | siltation, flooding, increased stream turbidity, changes ecosystem | L | LM | H | Y-Y |
| D. Overgrazing | ranching and farming | A | siltation, flooding, pollution | L | L | M | N-Y |
| E. Siltation | deforestation, construction, agriculture, erosion, overgrazing | AP | fills passages with soil/sand/clay/cobbles/wood, changes ecosystem | L | LW | H | N-Y |
| F. Flooding from External Causes | excess precipitation poor farming practice dams breaking, rapid snow melt | A | siltation, erosion, log jams and blocked passages, danger to visitors, provides nutrients for ecosystem | S | L | H | N-M |

TABLE III-28 EXTERNALLY DERIVED IMPACTS ON CAVES (Cont'd.)

| Action | Source | Cave Area Affected[1] | Nature of Impacts | Incidence[2] | | | Irreversible-Irretrievable[3] |
|---|---|---|---|---|---|---|---|
| | | | | Time | Space | Degree | |
| 3. Vibration and Noise | | | | | | | |
| A. Blasting | contruction, mining | FV | formation breakage, rock fall may disturb bats | S | L | H | Y-Y |
| B. Vehicles | highways,railways | FS | formation breakage,rock fall, collapse,increased breakdown | L | L | H | N-Y |
| 4. Limestone Mining and Quarrying | need for limestone | A | formation breakage,removal of cave | L | L | H | Y-Y |

Notes

[1] Abbreviations used: P--phreatic (below the water table, i. e., the aquatic portion of the cave environment); V--vadose (above the water table); A--all of the cave; E--ecosystem; S--sediments and fill; F--formations and the surface of the rock.

[2] These are rough approximations only and incidence may be affected by local conditions. Abbreviations: Time: L--long term; M--medium term; S--short term; D--duration of activity. Space: L--local; R--remote; U--universal; W--widespread. Degree: L--low; M--medium; H--high; V--varies.

[3] Abbreviations: Y--yes; N--no; M--maybe.

Source: Modified from Stitt. 1976

## Surface Ecosystems

The major surface water resource in the study area is the Green River. This river has high water quality and diverse biological communities. At present, wastes from Cave City and Horse Cave treatment facilities are discharged into the Hidden River Cave system which joins the Green River via a series of springs. The no-action alternative would continue the present discharges through the Hidden River System. All proposed treatment alternatives would involve discharge of treated wastewater effluent into the Green River at a single discharge point. These effluents would be upgraded from present treatment levels. Alternatives 6, 7, and 8 would involve the lowest discharge volume and Phase 2 of the preferred alternative the greatest volume. There would be potential degradation of the Green River aquatic community with complete failure of pretreatment for heavy metals or malfunction of the treatment plant at Horse Cave. Malfunction at the Cave City treatment facility could impact aquatic biota with proposed alternatives 1, 3, 4 and both phases of the preferred approach. Depending upon the quality of the effluent, adverse impacts to the aquatic community could result from introduction of effluents with toxic substances, high nutrient levels, high suspended solids or heavy nutrient concentrations. Construction and surface runoff could introduce large quantities of silt which would smother aquatic organisms and destroy their habitat. However, these impacts would not be highly significant due to the dilution factor of the Green River.

Short term impacts of aquatic communities could be moderate due to increased siltation from pipeline construction on the floodplain Construction of the diffuser system in the Green River could lead to extensive siltation if mitigative measures and best management practices were not enacted during construction activity. Diffuser system construction could be using a coffer dam. The building of the coffer dam, excavation of the pipeline trench, pumping of water and removal of the dam would produce sediment on the river. Some species such as mussels may take longer to become reestablished.

The natural vegetation of the study area has been greatly modified with the degree of modification influenced primarily by topography. Additionally gently rolling areas have been clearcut for agriculture and steep slopes have been selectively cut. This mosaic of farm and forest land has provided a variety of habitats for diverse animal communities. The remaining natural vegetation is a significant resource and its removal during construction or from changing land use would have adverse impacts on both plant and animal communities. The no-action alternative would not involve changes in present land use or construction and would not significantly impact the natural vegetation or wildlife.

All of the proposed alternatives would include pipeline construction. Alternative 8 would require the shortest distance of pipeline and Phase 2 of the preferred alternative the longest. The remaining alternatives would rank as follows from shortest to longest: 5, 6, 7, 3, 4 and 1. Phase 1 of the preferred approach would involve the next to the least amount of construction and, therefore, should not have too great an impact on vegetation or wildlife populations.

However, the pipeline routes would follow existing road right-of-ways or cross agricultural land for a short distance. The vegetation in these areas has been subjected to changes in land use and is not the natural vegetation. The only area of natural vegetation adversely impacted by pipeline construction would be in the floodplain at the proposed Green River discharge point. There is no difference in impact between alternatives since all alternatives would include construction at this point. Construction could cause removal of mature tree species as well as herbaceous species and could result in moderate to severe adverse impacts within the construction corridor. Overall, there would be no significant impact on the area's natural vegetation since the corridor would be small in relation to the floodplain ecosystem of the study area.

Facility construction would be required to some degree in all proposed alternatives. However this construction would involve removal of vegetation from agricultural areas and would not impact natural vegetation.

Increased capacity for wastewater treatment would permit growth in the study area which might result in land use changes. However, impacts upon prime agricultural lands would be minimized by EPA's policy which prevents the loss of significant agricultural land that results from its actions. EPA policy and regulations specifically discourage allocating federal funds to sewer interceptors which cross prime agricultural lands, unless they are needed to eliminate pollution or public health violations in existing developments.

## Rare and Endangered Species

According to the protected species list in Chapter III-Part B-12, the habitats of 5 protected, or formerly proposed species could be influenced by activities in the study area. This includes habitats of 3 mussel species, the Kentucky Cave shrimp and a mint. Although none of these species has been sighted in the study area during this project, the surveys were limited and seasonal.

The three mussels (*Lampsilis orbiculata orbiculata, Epioblasma torulosa torulosa, Pleurobema plenum*) have been found in the Green River. The no-action alternative would not change presently existing conditions and would not impact these mussels. All of the proposed alternatives, including the preferred alternative, would involve the placement of a single discharge pipe into the Green River. The discharge would be effluent from municipal and industrial wastewater facilities. This activity could impact the mussels in two ways: possible mussel and mussel habitat destruction by excessive sedimentation during the construction process and the possibility of toxic substances in the effluent harming the mussels. Construction activities involved in the pipeline placement and diffusing structure in the Green River could have potential for major short term impacts from sedimentation. Much of the impact from sedimentation would be mitigated through proper construction management processes. The slope where any pipeline would have to approach the river is currently a source of sediment pollution to the river. Long term construction impacts could be beneficial if proper bank stabilization procedures were incorporated into the alternative design.

Construction of the diffuser system for effluent discharge could produce significant, short-term detrimental impacts to the mussel fauna. Diffuser construction would probably involve the construction of coffer dam. The dam construction, removal and trench dewatering activities would produce significant amounts of sediment. Mitigative measures could be used to reduce the amount of sediment but would not eliminate all impacts. The alternate construction technique of sheet piling would produce much less sediment but is probably impractical for the area.

Long-term, direct impacts to the mussel fauna would be associated with the effluent discharge, although changes in water quality were not expected to be significant. The dilution factor based on low flow information for the Green River (7Q10:159 cfs) and maximum effluent flow (approximately 1 mgd) is approximately 250 (river) to one (effluent). Rapid dilution of the effluent would be facilitated by the diffuser system. Consideration of chlorine toxicity would be required in the system design in order to mitigate possible effects. Suspended solids (30 mg/l) and BOD (30 mg/l) were not anticipated to cause impacts to the mussel fauna. Proper design considerations must be given to ensure treatment system reliability and control possible system malfunctions.

The Kentucky cave shrimp *(Palgemonias ganteri)* is currently proposed for endangered status. Groundwater studies indicate that surface activities in the Park City-Cave City area could affect groundwater quality in the National Park and the critical habitat of this species. The Horse Cave and Cave City subsurface wastewater discharges to the Hidden River Cave system apparently have no influence on groundwater quality in the Park and any proposal affecting these facilities is unrelated to the Kentucky Cave shrimp. Therefore, the discussion of impacts of the alternatives on the Kentucky Cave shrimp will exclude the Horse Cave and Cave City facilities.

The no-action alternative involves the continuation of on-lot systems in a manner similar to existing practices in Park City and along Rt. 70. Since little or no protection would be afforded to the subsurface waters of the area that drain to the Park, it is expected that the Kentucky Cave shrimp could be adversely affected by the no-action alternative. Alternatives that propose the extension of sewers to Park City (1, 2, 3, 6), to the proposed Staging Area (1, 2, 4, 7) and the Rt. 70 area (2, 4, 7) would remove subsurface wastewater discharges and afford the subsurface waters and subsequently the Kentucky Cave shrimp the greatest amount of protection from the influence of wastewater. Alternatives that propose on-lot systems for Park City (4, 5, 7, 8), the proposed Staging Area (3, 5, 6, 8) and the Rt.70 area (1, 3, 5, 6, 8) would also result in improved wastewater management, compared to existing practices, and therefore benefit from these improvements, however, the protection from wastewater influences provided with properly designed, installed and maintained on-lot systems would not approach the level of protection associated with the removal of wastewater via the regional system. Construction activities would not be expected to have impacts on the critical habitat of this species. Minor, long-term negative impacts could be associated with non-point source runoff from new commercial development adjacent to the park which would be facilitated by regional alternatives. These impacts could be mitigated by implementation of best management practices by local authorities.

The mint Synandra (_Synandra hispidula_) is the only formerly proposed plant species whose distribution would indicate any possible impacts from the alternatives. The preferred habitat of wet woods and stream banks is found along the Green River. However, the steep slopes along the river limit the area to be considered for the pipeline route. Areas which would be suitable for the installation of pipeline would be exclusive of the required habitat for _Synandra_. Pipeline routes for all alternatives follow existing highways or traverse agricultural land. Secondary development associated with the alternatives would not lead to any increased development in areas of sensitive terrestrial habitat that would not be subject to development under the no-federal-action alternative.

## 2. IMPACTS ON THE MAN-MADE ENVIRONMENT

### Introduction

The man-made environment refers to the population and economy of the Mammoth Cave study area, as well as to the larger network of supporting facilities and institutions that provide service to the area. It is a dynamic environment, reflecting the continual interaction of cultural, political, demographic and economic influences. The section identifies the potential primary effects of all wastewater management alternatives on key aspects of this man-made environment. Primary effects are those impacts resulting directly from construction and operation of the proposed facilities. This section also identifies secondary impacts - those caused by the population growth and residential development that the proposed facilities will support. These however, are not extensive, since population is not expected to be impacted significantly by the proposed project.

Impacts upon the man-made environment resulting from construction and operation of the preferred alternative are not expected to be extensive. Generally the greatest impacts resulting from the construction of wastewater alternatives are the impacts upon population growth and land use. These are not significant items in this EIS. Population growth with or without the project will be very conservative. In addition, land use impacts will be minimal since few new areas will be served by the recommended alternative.

Therefore, the overall impacts of the preferred alternative upon the man-made environment might be the short-term impacts upon the area's economy during construction of the project.

The man-made parameters, and a discussion of potential impacts on them are presented in this section.

## Population

One of the major features of developing new or expanded wastewater facilities are the impacts upon population growth. Wastewater facilities serve as a stimulus to population growth which in turn impact a variety of man-made features. However, in the Mammoth Cave area it is not expected that extensive population growth will result from any new wastewater facilities. First population projections for the area are conservative. Secondly, the proposed wastewater facilities will include only limited new service area and, therefore, will not act as a direct stimulus to population growth. While impacts upon population growth will need to be observed, they are not expected to be significant.

The population projections presented on Table III-1 in Chapter III, Part C, Existing Man-Made Environment, support the statement that implementation of the preferred alternative will not significantly effect population growth rates in the study area.

Sewering of the Route 70 area in Alternatives 4, 7, and Phase 2 of the preferred alternative may stimulate some additional population growth, however, this growth is not expected to be significant.

Alternatives 1, 3, 6, and Phase 2 of the preferred alternative call for construction of collection and treatment facilities at Park City. These facilities could serve as a stimulus to population growth in this area, but again, growth would not be significant.

## Land Use

Contrary to the impacts upon population, it is felt that some impact upon land use could occur in the study area. The selected alternative calls for upgrading the treatment facilities at Cave City and Horse Cave. This could stimulate limited industrial development activity in those areas because of improved treatment and resolution of the disposal problems. Also, the fact that the capacity of these treatment plants is more than adequate for the existing population, could provide a further stimulus to industries. The development of a community sub-surface absorption field - Alternatives 4, 7, 8 and phase 1 of the preferred alternative - for the Park City business district, could stimulate other other business activities to locate in the town. The construction of new wastewater treatment facilities in Park City (Alternatives 1, 3, 6 and phase 2 of the preferred approach) may stimulate some additional residential growth in Park City, but it is not expected to be significant. One of the major concerns in the study area is the tourism related development which has occurred along Kentucky Route 70. These establishments utilize on-lot systems and are contributors to water quality problems. Severing this area would correct this problem but would also stimulate additional growth in this area. The preferred alternative does not provide for immediate severing and therefore would not resolve the Kentucky Route 70 issue. Alternatives 4, 7 and phase 2 of the preferred alternative call for immediate severing of the Route 70 area. This would solve water quality problems in the area and, in addition, would stimulate growth in the area - primarily business establishments.

The right-of-way areas for interceptors and force mains in all alternatives will be permanent changes in land use. However, their overall effect will not be adverse, in that the right-of-way can be available for other public uses such as hiking trails. The only visible evidence of the interceptor or force main following construction will be the manholes located at various intervals along the right-of-way.

## Economic Conditions

The impact upon the local economy will come from both the short term construction impacts and the long term investment from the improvement of wastewater treatment in the study area. Construction activities associated with the preferred alternative will be fairly extensive and should have some short term impacts upon the study area. The effects of construction on the local economy would depend upon where workers reside and where equipment and materials are purchased. It is likely that the project would create construction employment and would also pump additional money into the local economy for the purchase of housing, equipment, and materials. The long term impacts of the preferred action and the resultant improved treatment, include:

- potential stimulus of industrial growth
- potential increase in visitors due to improvement of water quality in the Hidden River Cave System
- Improvements would insure the continuation of Mammoth Cave as a unique natural resource and therefore guarantee the future tourism industry in the area.

During the EIS process, one of the key issues considered was the financial impacts of wastewater management systems and funding options. A major concern was the ability of the local communities to pay for an environmentally sound management system. Taking into consideration the relatively high unemployment rate and low per capita income of the study area, a semi-regional system having the next to the lowest net present worth cost of all the alternatives was selected (first phase of the preferred alternative), with eventual regionalization of the system if the National Park Service constructs the Staging Area (Second phase). Alternatives 1, 2, 3, 4, 6 and 7 have net present worth costs higher than phase 1 of the preferred alternative (essentially Alternative 5). Each of these could place financial burdens of varying degrees on the study area communities. Phase 2 (Alternative 2) of the preferred approach has the highest net present worth cost of all alternatives. This phase, if implemented, has the potential to place somewhat of a greater financial burden on the local communities than phase 1 of the approach. Since none of the alternatives would increase population significantly, there should be minimal demand on the local economy to provide increased public services and facilities.

## Historical, Cultural and Archaeological Resources

There are very few man-made sites of archaeological and/or historical significance in the Mammoth Cave study area. Although, the precise force main routes for the wastewater alternatives have not been determined, it is expected that no significant conflicts between these sites and the routes will occur.

One very important natural resource of the study area is the Mammoth Cave National Park, also considered a cultural resource. A key issue of this EIS has been the preservation and protection of the areas cave systems, and their unique physical, biological and historical resources. All alternatives including the selected alternative should have a positive impact on this cultural resource by improving the quality of water entering the areas surface and subsurface water systems.

## Recreational Resources

Recreation is a vital factor in the study area because of the Mammoth Cave National Park and the supporting facilities and services. Recreation oriented business is the major industry in the study area. The selected alternative is not expected to have any significant adverse impact on the recreational resources of the area. One beneficial impact of upgrading facilities may be the restoration of the recreational value of the Hidden River Cave through improvement of the water quality of the Hidden River. Since population is not expected to increase significantly as a result of this project, demand for additional recreational resources, such as parks, in the study area is not anticipated. Alternatives 4, 7 and phase 2 of the preferred alternative would provide sewer service to the Kentucky Route 70 area. This may stimulate the growth of additional recreation oriented businesses along Route 70, adjacent to the Park.

## Transportation Facilities

Transportation facilities can be impacted through construction activities and increased demand associated with secondary growth. The latter development is not anticipated, since secondary growth is not expected to be significant. It is possible that some interruption of normal highway traffic could be caused by construction of conveyance facilities.

One item which bears mentioning is the proposed construction under the preferred alternative. Under this alternative a force main would be constructed to the Green River to convey treated wastewater from Horse Cave and Cave City. While a specific corridor for the force main has not been selected, the force main would cross I-65, which would require tunneling under the interstate highway. However, this is not expected to disrupt traffic on I-65. Although specific force main corridors have not been chosen for any of the eight alternatives, impacts to transportation facilities and traffic patterns are not expected to be significant.

## Resource Use

None of the alternatives are expected to exert undue pressure on resource supply or availability in the study area. Currently, most of the area where development of wastewater facilities will take place, is forested, vacant or used for agricultural purposes. Several acres of land will be required for construction of conveyance facilities. Extensive clearing of forested lands, or interruption of commercial forest activities is not anticipated, however. Construction of conveyance facilities may utilize agricultural lands temporarily disrupting agricultural activities, however, except for manholes, the pipelines should not be noticeable in this area when construction is complete. Other local resources used to some degree as a result of upgrading current facilities and construction activities are electric power and labor.

## Wastewater Treatment Facilities and Programs

The proposed action should have a positive impact on current treatment facilities and programs. Implementation of the selected alternative would upgrade Horse Cave treatment processes to provide secondary treatment. This should result in improved effluent quality, thereby improving water quality.

Also, as a result of this project, the Cave City treatment facilities would be upgraded to improve plant performance, resulting in improved effluent quality.

The construction of a force main from these plants to the Green River will solve the problems of Horse Cave's and Cave City's sub-surface discharges, thereby aiding in the protection of sub-surface caves and water resources.

Continued use of conventional and alternate on-lot systems at Park City has the potential to adversely impact the sensitive underground water resources that flow through the Park. Should the National Park Service develop the Staging Area and should funding assistance become available to Park City, then the second phase of the alternative would be implemented. This would involve construction of facilities at Park City and the Staging Area and service to Route 70 business establishments now using on-lot systems. This would have the positive impact of removing the current potential for groundwater pollution by way of the extensive on-lot systems currently used in Park City and on Route 70.

No action proposed under any of the eight alternatives is expected to produce negative impacts on current treatment facilities and programs.

## Water Supply

The major water supply source for the study area is the Green River and several springs. The proposed action should not have any impact on the water supply of the study area other than to potentially improve, to some degree, the quality of groundwater by eliminating some subsurface discharge of effluent. Discharge of effluent (secondary treatment) to the Green River (as is proposed in all alternatives) should not adversely effect the use of that stream as a water supply source. Only Park City receives its water supply from the Green River. The intake location for this supply is at Brownsville, Kentucky, downstream of the study area. The alternative preferred provides the greatest degree of protection to the groundwater supply sources of the study area. In addition, due to the lack of expected population increase as a result of the project, there should not be any great additional demand placed on the water supply sources of the area.

## Community Services and Facilities

Community services include health care, education and libraries, fire protection, police protection, and the administrative structure to manage those services. Generally, impacts to community services are associated with increased population size. This larger population will create a demand for expansion of public facilities. However, since population increases are not projected to be significant in the Mammoth Cave study area, the requirements for expanded community services and facilities should not be significant.

## 3. ENVIRONMENTAL EVALUATION

In order to incorporate environmental impacts evaluation into a cost effectiveness analysis or to compare relative impacts of one wastewater management alternative with another, it is necessary to quantify or assign a numerical value to this subjective evaluation. This section deals with the development of numerical environment impacts ratings for both the natural and man-made environment and includes a description of the evaluation methodology, a numerical ranking of the eight wastewater management alternatives with respect to natural and man-made environment impacts, and a discussion of the impacts for each of the alternatives.

A parameter-checklist evaluation methodology was used for the evaluation of impacts to the natural environment for the eight wastewater management alternatives. This methodology presented a specific list of environmental parameters to be investigated for possible impacts but did not require the establishment of direct cause-effect links to project activities. The list of parameters to be investigated was based on the Environmental Inventory prepared for the project, with special emphasis on those resources that had been identified as sensitive.

A scaling-weighting checklist was used in this project for the evaluation of potential impacts to the environment. Scaling factors were used to estimate the relative magnitude of impacts while weighting factors were used to estimate the relative importance of impacts. Weighting (importance) factors were assigned to each environmental parameter and were constant for all alternatives. Scaling factors varied according to the magnitude of the impact for each alternative.

Factors were assigned to the parameters by an interdisciplinary team of biologists, planners and engineers. Weights and scales ranged from no impact or importance to a highly significant level of importance or impact. Impact scaling factors could be beneficial (+) or adverse (-). The score for an environmental parameter wastewater management alternative combination is the product of the wright and the scale. The summation of the parameter alternative scores for an individual alternative yields a cummulative comparative score for that alternative.

Environmental parameters, weighting factors, scores and alternate cummulative scores are summarized in Table III-29.

The natural environmental evaluation scores indicate that the eight wastewater management alternatives cluster into three groups. The most desirable alternative is WMA-2 which is eight points above the second best alternative. The second through sixth ranked alternatives (WMA-4, WMA-1, WMA-3, WMA-5, WMA-7) are roughly equivalent being separated by six points. The final two alternatives (WMA-6, WMA-8) are clearly the least desirable with total environmental evaluation scores of less than 50 points.

The man-made environmental evaluation scores also segregate into functional groups. The most desirable alternatives are WMA-2 and

TABLE III-29. ENVIRONMENTAL EVALUATION PROCESS. ENVIRONMENTAL PARAMETERS, WEIGHTING FACTORS, SCORES AND ALTERNATE CUMULATIVE SCORES.

| Parameter | Weight | Wastewater Management Alternatives | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | WMA-1 | WMA-2 | WMA-3 | WMA-4 | WMA-5 | WMA-6 | WMA-7 | WMA-8 |
| | | Score | | | | | | | |
| Climate | 1 | 0 | 0 | 0 | 0 | 0 | 0 | -1 | 0 |
| Air Quality | 1 | -2 | -2 | -2 | -2 | -1 | -2 | -3 | -1 |
| Odor | 1 | 4 | 4 | 3 | 4 | 4 | 3 | 4 | 3 |
| Topography | 1 | -3 | -3 | -2 | -2 | -1 | -2 | -2 | 0 |
| Geology | 2 | -4 | -4 | -4 | -4 | -2 | -4 | -4 | -2 |
| Soils | 2 | 0 | 0 | 0 | 0 | 0 | 0 | -2 | 0 |
| Noise | 1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| Subsurface Water Resources | | | | | | | | | |
| Quality | 4 | 12 | 12 | 12 | 12 | 16 | 4 | 8 | 4 |
| Surface Water Resources | | | | | | | | | |
| Quality | 3 | -3 | -3 | -3 | -3 | -3 | -3 | -3 | -3 |
| Quantity | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Cave Ecology | 4 | 8 | 8 | 12 | 8 | 12 | 4 | 12 | 4 |
| Surface Ecosystems | 2 | -6 | -6 | -4 | -4 | -4 | -2 | -2 | -2 |
| Rare & Endangered Species | 4 | 16 | 16 | 16 | 16 | 12 | 12 | 12 | 8 |
| NATURAL ENVIRONMENT TOTAL | | 22 | 22 | 28 | 24 | 33 | 10 | 19 | 11 |
| Population | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Land Use | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| Economic Conditions | 2 | 8 | 8 | 4 | 4 | 2 | 4 | 4 | 2 |
| Historical, Cultural & Archaeological Resources | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| Recreational Resources | 4 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 |
| Transportation Facilities | 1 | -3 | -3 | -2 | -2 | -1 | -1 | -2 | 0 |

TABLE III-29. ENVIRONMENTAL EVALUATION PROCESS. ENVIRONMENTAL PARAMETERS, WEIGHTING FACTORS, SCORES AND ALTERNATE CUMULATIVE SCORES.
(Cont'd.)

| Parameter | Weight | Wastewater Management Alternatives | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | WMA-1 | WMA-2 | WMA-3 | WMA-4 | WMA-5 | WMA-6 | WMA-7 | WMA-8 |
| | | Score | | | | | | | |
| Resource Use | 1 | -1 | -1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Wastewater Treatment Facilities & Programs | 3 | 12 | 12 | 9 | 9 | 12 | 12 | 12 | 12 |
| Water Supply | 3 | 12 | 12 | 12 | 12 | 12 | 3 | 6 | 3 |
| Community Services & Facilities | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| MAN-MADE ENVIRONMENT TOTAL | | 46 | 46 | 41 | 41 | 43 | 36 | 38 | 35 |

WMA-4 while the least desirable is WMA-8. Environmental evaluations are summarized by ranking the wastewater management alternatives in Table III-30.

## PART E. MITIGATIVE MEASURES

### Introduction

The purpose of this part is to discuss measures which would reduce the severity of those environmental impacts outlined in part D. These mitigative measures address activities to be instituted during the design, construction and operation phases of the preferred alternative. While these mitigative measures will not eliminate the environmental impacts, they will reduce the severity of identified adverse impacts. It should be noted that many of the measures identified in this part are not within the purview of EPA to implement, but are the functions of state or local governments.

## 1. MITIGATION OF IMPACTS ON THE NATURAL ENVIRONMENT

### Introduction

This section addresses the areas of impact described in Part D, Section 1 of this chapter. In each case where an adverse impact on any natural parameter is anticipated, potential mitigative measures are discussed. Generally, adverse impacts on natural resources are the result of construction activities. Therefore, for the most part, mitigative measures deal with effective methods of mitigating potential impacts during and immediately following construction.

### Air Quality

While some impacts on air quality will be long term in nature they will be primarily minor. These long term impacts will be associated with a modest amount of secondary growth and additional traffic. The short term construction impacts on air quality will be more noticeable but will still be moderate in nature. Suspended particulates (dust) and equipment emissions are expected to increase during construction. They may be mitigated by the following controls:

1. utilize construction equipment which meets current emission standards

## TABLE III-30
## ENVIRONMENTAL EVALUATION PROCESS
### Natural and Man-Made Evaluating Ranking of Alternatives

| Alternative Number | Natural Environmental Evaluation Ranking | Man-Made Environmental Evaluation Ranking |
|---|---|---|
| 1 | 4 | 1 |
| 2 | 4 | 1 |
| 3 | 2 | 4 |
| 4 | 3 | 4 |
| 5 | 1 | 3 |
| 6 | 8 | 7 |
| 7 | 6 | 6 |
| 8 | 7 | 8 |

2. immediately revegetate all cleared areas during the construction process

3. utilize scheduled and frequent dust containment practices such as the spraying of exposed areas

4. minimize the amount of land under active construction at any one time

5. minimize open burning during construction activities.

### Odor

Overall impact of the alternatives on odor will be beneficial. Major improvements in odor will be associated with the removal of effluents from the Hidden River cave system under all alternatives except the no-action alternative. However minor odors may originate from upgraded treatment facilities at Horse Cave and Cave City or from any new facilities. These minor impacts can be mitigated by the following controls:

1. control land use of areas adjacent to treatment sites in order to discourage residential development and encourage agricultural or industrial development

2. institute proper sludge management techniques in order to reduce odor production.

### Noise

The impacts of noise will be noticeable only during construction activities. Long term impacts to noise will be associated with treatment plant and pump station operation but should be minimal, as should be increases in noise from secondary growth. Construction impacts can be mitigated by:

1. requiring sound control devices on construction equipment

2. limiting construction activities to normal business hours.

### Geology

Adverse impacts to local geologic formations should be limited to the affects of blasting activities. These impacts can be mitigated by the use of site-specific studies to determine the proper blasting procedures.

## Soils

The major soil impact will be through soil erosion during construction. This impact can be reduced by:

1. limiting the size of the pipeline corridor to the minimal possible area of disturbance
2. prepare and strictly enforce construction plans which require the rapid stabilization and revegetation of construction areas
3. institute best management controls in order to reduce the amount of non-point source runoff from construction sites.

## Surface Water Resources & Aquatic Ecology

The major surface water resource in the study area is the Green River. Impacts to the river will be associated with the construction and operation of the effluent pipeline and discharge diffusing structure. The primary construction impacts will be due to erosion and sedimentation. These impacts can be mitigated by the following activities:

1. utilizing best management practices to limit erosion during construction activities
2. during installation of the diffuser system, institute policies calling for the use of either riprap or gabbions to reduce erosion
3. pumping drainage water from the pipeline trench into a settling pond rather than directly into the river
4. incorporate bank stabilization structures in the pipeline area
5. revegetation of bank area immediately after construction.

Due to the comparatively large flow of the Green River, even at low flow, the effluent will be quickly diluted during periods of normal treatment levels. However, serious impacts to the river could be realized if severe plant malfunctions occur such has happened at Horse Cave in the past. Local pretreatment ordinances, strict enforcement and design requirements for retention ponds will be necessary measures in ensuring the quality of the Green River.

## Subsurface Water Resources and Cave Ecology

Major benefits to the subsurface systems will be associated with the removal of existing subsurface discharges. Additional protection would be provided by the regional alternatives which include effluent transport from Park City via either Route 70 or Highway 31W. However, the regional alternatives will include extensive pipelines. The potential for leaks or breaks in this pipeline is greater than in most areas due to the unstable geologic conditions. Leakage from these pipelines of either raw or treated effluent would be detrimental to the groundwater resources and could be disasterous to the biotic cave systems. In order to mitigate these impacts detailed design and construction of the pipeline will be required. The pipeline should include a series of flow meters to facilitate the detection of leaks.

Secondary, detrimental impacts may be caused by urban runoff, leaking fuel tanks or spills associated with increased development along major transportation routes. Under all alternatives local land use and zoning restrictions are needed in order to protect the cave systems of the area for degradation. These restrictions would not only protect the subsurface resources but would also protect the economic benefits of the tourist industry to the area.

## Rare and Endangered Species

While most of the protected species listed by the U.S. Fish and Wildlife Service will not be impacted by any of the alternatives concern has been expressed over five species.

Three protected mussel species may be present near the effluent discharge point at the Green River. Mitigative measures described under surface water resources should mitigate many of the construction impacts. Dr. Arthur Clarke of the Smithsonian Institution; Division of Mollusks; Washington, D.C. will be doing a survey which will include the Green River during the summer and fall of 1981. The results of this survey should be incorporated into the design and construction activities associated with the outfall structure.

The Kentucky Cave shrimp will not be directly impacted by the Project alternatives. However, the regional systems and particularly alternative 2 can provide extensive protection for the species. Mitigative measures outlined under subsurface water resources should be implemented to protect this species. Alternative construction activity would impact only one area where any formerly proposed plant species may exist. Synandra could possibly be present along the bank of the Green River. This species has not been reported from the probable pipeline location and has not been seen during this study. Presence of this species is unlikely due to the modified habitat at the probable pipeline site. However, prior to construction a final site survey should be conducted. If any species of special concern is located in an area of possible impact from the pipeline then such species should be transplanted to other areas.

## 2. MITIGATION OF IMPACTS ON THE MAN-MADE ENVIRONMENT

### Introduction

This section addresses the areas of impact described in Part D, Section 2 of this chapter. In each case where an adverse impact on any man-made parameter is anticipated, potential mitigative measures are briefly discussed. These mitigative measures, for the most part, involve implementation of tools for effective planning and environmental protection in the Mammoth Cave study area.

### Population and Land Use

The proposed plan is not expected to cause any dramatic increases in population of the area, therefore mitigative measures are not necessary. Impacts on land use are not expected to be significant, however there are available several planning and regulatory tools to be employed by the municipalities and government agencies, that would be effective in managing growth and environmental change, no matter how slight. Through effective management of land use, any potential increases in population would also be managed effectively. Planning and regulatory tools considered are discussed in the following section. Tools which would potentially regulate industrial development are emphasized since the likelihood of land use change is greatest in the industrial sector.

Land Use and Development Controls. In order to effectively plan and manage land resources, there is a variety of techniques available to municipalities in the study area. The following specific land use and development controls could be made available to municipalities to help management land use effectively.

a. Comprehensive Plans - The comprehensive plan provides a complete framework for community development. The Plan includes goals and objectives, a land use plan, transportation plan, community facilities plan, an evaluation of environmental considerations, and the community's relationship to the region and to adjacent communities. Should a comprehensive plan be developed, it would act as an aid in planning the most efficient site for industrial development.

b. Zoning Ordinances - The zoning ordinance is a strong tool for implementing a comprehensive plan through the municipality's inherent power to exercise reasonable control over property and persons under its jurisdiction. Zoning regulations are not widespread in the study area. As a matter of fact, Hart and Edmonson Counties have no zoning ordinances. Barren County does have zoning, but it is not enforced in any portion of the Study Area.

c. Easements - Positive and negative easements are ways to acquire a permanent interest in land. Governments, individuals, and organizations may obtain positive easements in order to establish the legal right to use part of another's private land for certain limited and stated purposes. Negative easements permanently limit an owner's use of his land, but do not provide for public use. For example, the purchase of conservation easements would limit development in critical areas such as woodlands, rugged terrain, flood plains, and open space.

d. Fee Simple Acquisition of Land - The outright acquisition of land can be accomplished through purchase and lease-back arrangements with a willing owner. Land subjected to tax delinquency can be purchased at certain auctions, or land can be acquired if there is a mortgage in default of payments. Gifts of land are also possible from citizens, groups, and corporations to municipalities, conservancies, and other organizations. Scenic or conservation easements can be purchased to protect natural resources.

e. Conservation Zoning District - These are established to control development in areas where physiographic problems exist such as steep slopes, difficult access, or outstanding natural beauty and environmental value. These areas might be appropriate for uses such as forestry, recreation, agriculture, and perhaps even some low-density residential development.

Floodplain Ordinances. As more and more land is developed, it is essential that floodplains remain undeveloped and protected in order to minimize damages resulting from flooding. Floodplain zoning districts should protect, at a minimum, all lands located within the 100-year flood zones of every stream. In general, no structures or fill should be allowed in these areas, and land uses should be restricted to agriculture, recreation, and other appropriate land uses. At present, there is a proposal for the development of a 10,000 acre park along the Green River between Munfordville and Mammoth Cave National Park.

Control of Non-Point Pollution Sources. There are a number of administrative and regulating approaches to reducing the impact of non-point source pollution. These include the following: a) Soil Erosion and Sediment Controls - Under natural conditions where soils are protected by a vegetative cover, only controlled amounts of nutrients are released to flowing waters. However, when natural conditions have been altered by removal of vegetation cover, the erosion process is accelerated. Eroded sediments when transported to streams can destroy the balanced biological conditions necessary for a diverse aquatic community. Sediments also carry fertilizers which accelerate the aging of lakes and ponds, pesticides which have a toxic effect on aquatic organisms, and heavy metals which can also be toxic. In addition to being a pollutant, sediment increases flood crests, because rainfall runs off eroded lands more quickly, reduces the hydraulic capacity of water courses by filling stream channels, makes surface waters more costly to treat for human consumption, interferes with the assimilative capacity of waterways, and degrades the appeal of water-based recreation.

Soil erosion and sediment control plans should be required of all construction activities which require the removal of protective vegetation. These plans will minimize runoff during construction and provide for soil stabilization immediately afterward.

There have also been a variety of manure management systems developed which can reduce some of the water quality problems associated with daily manure applications. The daily application of manure can have many adverse impacts such as odor, excessive runoff especially during winter, insect problems, and possible crop damage resulting from heavy application on some crops. Manure management techniques available include: liquid manure storage in an above-ground silo, a slotted dam system for manure handling, earthen bank storage, and spray irrigation of manure. These systems allow the farmer other alternatives for storing and managing manure rather than the alternative of daily application.

### Economic Conditions

The selected alternative is not expected to cause any significant, long-term adverse impacts on the economy of the study area.

### Historical, Cultural and Archaeological Resources

There is a potential that undetected archaeological and/or historical resources could be present within areas of planned construction. Construction of pipelines could ruin the value of these resources. In order to mitigate or avoid any adverse impacts to historic and archaeological resources, the Kentucky Heritage Commission suggests having a qualified archaeologist do a standard archaeological and historic sites survey prior to construction. This survey is mandatory, as it is required by the advisory council of the National Register of Historic Places.

Any historic sites encountered on the route, and not listed on the National Register, could be photographed, and consultations with the Kentucky Heritage Commission or other agencies would determine the significance of the site and its eligibility for on inclusion the list of Historic Places.

### Recreational Resources

Mitigative measures are not called for here, since the proposed action will not cause any significant adverse impacts to existing recreational resources, nor will it cause demand for additional resources. Should the second phase of the proposed action be implemented, it may then become necessary to implement the planning tools discussed earlier to alleviate any unplanned strip development along Route 70 in the vicinity of the Park.

## Transportation

There is no need to alleviate transportation problems caused by secondary growth, since extensive secondary growth is not anticipated. Should the second phase of the proposed action be implemented it may be necessary to alleviate congestion caused by secondary growth, particularly along Route 70 in the vicinity of the park. This, again, can be accomplished through planning. Planning for growth allows local governments to establish a network of feeder routes and streets that both alleviate congestion and tend to organize residential patterns. Air and noise pollution can also be reduced using careful transportation planning.

## Resource Use

Again, any adverse impacts to resources can be mitigated through use of planning tools. The implementation of soil erosion and sedimentation control plans might help alleviate any sediment problems caused by removal of the protective cover when laying interceptor lines.

## Water Supply

No adverse impacts to water supply sources are anticipated, therefore mitigative measures are not discussed.

## Community Services and Facilities

A demand for additional facilities as a result of the proposed action is not expected. However, planning tools should be implemented which would make available sufficient space for facilities should the need for additional facilities, at some time, arise.

# CHAPTER IV - EIS COORDINATION

## PART A. INTRODUCTION

Public participation is an important part of the EIS Process. It provides for active public involvement in developing and evaluating wastewater facilities and moreover it is required by federal regulations governing the preparation of environmental impact statements.

At the beginning of the Mammoth Cave Area EIS a public participation program was established to provide opportunities for interested groups, individuals and governmental agencies to participate in the development of the EIS. The focal point of this program was the establishment of a Citizen Review Committee. This group served in an advisory capacity to EPA and their consultant, GFC&C, Inc. Specific functions and duties of the group included:

- Identify local planning and environmental objectives
- Identify study area issues and conflicts regarding wastewater disposal and environmental conditions
- Review all task report submissions,
- Assist in the development and evaluation of wastewater alternatives
- Review Draft and Final Environmental Impact Statements.

The Citizen Review Committee has met at regular intervals throughout the development of the EIS. They have responded to reports prepared by EPA, provided local sentiments on wastewater issues and developed for EPA and their consultant the needs and sensitivities of the study area.

In addition to the Citizen Review Committee, another vehicle for public participation was developed. This was in the form of a Groundwater Technical Advisory Committee (GTAC). Since sub-surface water was and is a critical issue in the study area it was felt that a technical committee should be developed to review data, provide technical input and assist in developing a groundwater sampling program to determine sub-surface water quality.

## PART B. COORDINATION WITH LOCAL, REGIONAL, STATE, AND FEDERAL AGENCIES

Throughout the EIS process, it was necessary to contact many agencies - local, regional, state and federal - in order to gather data which aided in the preparation of the various documents produced Table IV-1 is a listing of those agencies contacted, and the information made available by them for use in the EIS.

## PART C. PUBLIC PARTICIPATION PROGRAM

### 1. CITIZEN'S REVIEW COMMITTEE

### Introduction and Purpose

The establishment of a Citizen's Review Committee was an important aspect of the Mammoth Cave Environmental Impact Statement (EIS) Public Participation Program. The committee was formed with the express purpose of focusing the attention of local residents and public agencies on the EIS. The committee consisted of 18 members and was representative of a cross-section of local interests. Each member of the group was asked to review and comment on all study materials, as well as to offer any other input during the course of the study. Several committee meetings were held throughout the study for review purposes. The contribution of the group was especially important in providing EPA with the information necessary to identify a preferred alternative.

On November 22, 1977, a public meeting was held to describe the EIS study plan. The meeting included presentations on the Purpose and Background of the EIS; the 201 Study; the Scope of the EIS and Issues to be Addressed; the EIS schedule; and a description of the Public Participation Program.

The first meeting of the CRC was held on March 8, 1978 in Horse Cave for the purpose of constituting and organizing the group. Those representatives of various public agencies and other citizen's interested in contributing to the preparation of the EIS attended this meeting. Table IV-2 presents a listing of the Citizen's Review Committee members and the organizations they represent.

Once the committee was organized, a series of meetings were held to present the development of the EIS and to receive their comments and ideas. The following section presents a brief synopsis of each meeting.

## TABLE IV-1
## COORDINATION WITH FEDERAL, STATE, REGIONAL AND LOCAL AGENCIES

### Federal Government Contacts

| Contact | Purpose |
|---|---|
| U.S. EPA, Region IV<br>EIS Branch<br>Atlanta, GA | Obtain EPA Program Requirements for Land Application |
| U.S. Geological Survey<br>Reston, VA | Obtain mylars of USGS quandrangles for the study area |
| Mammoth Cave National Park<br>U.S. National Park Service<br>U.S. Department of Interior<br>Mammoth Cave, KY | Obtain Master Plan and EIS for Mammoth Cave National Park |
| James F. Quinlan<br>Research Geologist<br>Uplands Research Lab<br>U.S. National Park Service<br>U.S. Department of Interior<br>Mammoth Cave, KY | Obtain data involving dye tracing and water quality sampling in sub-surface streams. |
| **State EIS Contacts** | |
| Kentucky Department for Natural Resources and Environmental Protection<br>Bureau of Environmental Protection<br>Division of Sanitary Engineering<br>Frankfort, KY | Water supply demand and capacity figures Munfordville, KY |
| Kentucky Dept. for Natural Resources and Environmental Protection<br>Division of Water Quality | Waste load assimilation studies. Influent and effluent data for Horse Cave treatment plant. |
| University of Kentucky<br>Kentucky Geological Survey<br>Lexington, KY | Obtain geological data |
| Kentucky Department of Commerce<br>Frankfort, KY | Obtain industrial resources data |
| **Regional and Local EIS Contacts** | |
| Barren River Area Development District<br>Bowling Green, KY | Obtained a variety of data Population, Water Quality, Water Resources, Land Use, Economic Studies, Transportation, Recreational Facilities, Infiltration/Inflow, Ken Dec, Inc. & Hart County Creamery Wastewater Characteristics, 201 Facilities Plan |

TABLE IV-1 (Cont'd.)
COORDINATION WITH FEDERAL, STATE, REGIONAL
AND LOCAL AGENCIES

Regional and Local EIS Contacts (Cont'd.)

| Contact | Purpose |
|---|---|
| Barren County Health Dept.<br>Glasgow, KY | Locations of known well contamination and other well information. |
| Edmonson-Hart County Health Department<br>Brownsville, KY | Locations of known well contamination and other well information. |
| **Other EIS Contacts** | |
| Ken Dec, Inc.<br>Horse Cave, KY | Information on wastewater discharged to the Horse Cave sewerage system from Ken Dec, Inc. |

## TABLE IV-2
## MAMMOTH CAVE AREA ENVIRONMENTAL IMPACT STATEMENT
## CITIZEN REVIEW COMMITTEE MEMBERS

| Representing | Name | Address |
|---|---|---|
| Horse Cave, KY | Mayor Robert L. Bybee | City Hall<br>Horse Cave, KY<br>42749 |
| Munfordville, KY | Mayor Chester Fryer | City Hall<br>Munfordville, KY<br>42765 |
| Cave City, KY | Mayor Clyde Hubbard<br>Alt: Charles Lohden | City Hall<br>Cave City, KY<br>42127 |
| Park City, KY | Chairman, Board of Trustees<br>Robert L. King | City Hall<br>Park City, KY<br>42160 |
| Green River Valley Water District | Elmore Larimore | Country Manor EST<br>Box 103<br>Horse Cave, KY<br>42749 |
| Barren River Area Development District | Ken Smith | Barren River Area Development District<br>PO Box 154<br>Bowling Green, KY<br>42101 |
| National Park Service | Robert Deskins, Park Superintendent | PO Box 65<br>Mammoth Cave, KY<br>42259 |
| Industry | Franz Donin | Ken Dec, Inc.<br>Box 128<br>Horse Cave, KY<br>42749 |
| DNREP | Joe Thornton<br>Kentucky Division of Water Quality, Dept. for Natural Resources and Environmental Protection | U.S. 127 South<br>Frankfort, KY<br>40601 |
|  | Tom Aley | Ozark Underground Laboratory<br>Protem, MO<br>65733 |
| Industry | Nick Gunn | Box 442<br>Horse Cave, KY<br>42749 |

## TABLE IV-2 (Cont'd.)
## MAMMOTH CAVE AREA ENVIRONMENTAL IMPACT STATEMENT
## CITIZEN REVIEW COMMITTEE MEMBERS

| Representing | Name | Address |
|---|---|---|
| Industry | Otis Cagle | Box 187<br>Horse Cave, KY<br>42749 |
| Citizen | W.T. Austin | PO Box 527<br>Horse Cave, KY<br>42749 |
| Citizen | Charles Neville | Park City, KY<br>42160 |
| Citizen | Tom Chaney | PO Box 91<br>Horse Cave, KY<br>42769 |
| Cave Research Foundation | Joseph Kulesza | PO Box 215<br>Park City, KY<br>42160 |

## Review Committee Meetings

A meeting of the Citizen's Review Committee was held on August 8, 1978 to discuss the Draft Environmental Inventory Report. All of the study area communities, including the national park, were represented at the meeting, with the exception of Munfordville. The area outside the incorporated cities and the Cave Research Foundation were also represented. In addition to a review of the inventory report, the committee was also updated on the progress of the 201 Study being performed by Campbell Wallace, Inc. of Knoxville.

The second committee meeting, held on February 14, 1979, was for review of the Draft Alternatives Development Task Report and the supplemental report on Water Quality and Biological Resources. In addition, Mr. Campbell Wallace, Jr. presented the 201 Wastewater Facilities Plan developed by his firm. A preliminary draft of that study had been submitted to EPA.

The review committee discussed and modified 11 alternatives presented at the meeting. The alternatives included each city maintaining its own disposal and treatment system and various combinations of systems run jointly by more than one population center. The committee also reviewed the Water Quality and Biological Resources Study, a supplement to the Environmental Inventory, reviewed by the committee in August, 1978.

A third committee meeting was held on August 27, 1979. The purpose of the meeting was for review of the Draft Alternatives Evaluation Task Report, including the review of engineering and environmental evaluations developed in the report. Eight alternatives for an area wide sewage plan to serve the study area communities and the National Park were evaluated by the committee. Each member of the committee was asked to complete a "Wastewater Management Alternatives Implementability Rating" sheet, which provided a written survey of attitudes regarding the implementability of each wastewater management alternative.

A fourth review committee meeting was held on February 25, 1981 in Cave City. This meeting involved a discussion of the eight wastewater alternatives, including the pros and cons of each alternative, and selection and discussion of the preferred alternative. The status of the 201 Facilities Plan was also presented at this meeting.

## 2. GROUNDWATER TECHNICAL ADVISORY COMMITTEE (GTAC)

### Purpose

The GTAC was formed for the purpose of supplementing the input of the Citizen's Review Committee. The group consists of scientists and technical personnel who are highly familiar with the unique hydrologic and geologic conditions of the area. A major role of the group was to aid in understanding the underground environment and the flow of water in the sinkhole plain, and the impacts sewage effluent would have on this natural resource. The group provided technical assistance in the development of the water quality sampling program. The five members of the group are presented in Table IV-3. Several additional technical persons provided input to the group during the course of the study.

### GTAC Meetings

The Groundwater Technical Advisory group held two meetings. The first, on August 9, 1978, was for review of the status of the water quality sampling program and the development of subsurface water quality standards. In addition, the group reviewed and commented upon the Draft Environmental Inventory Report.

The second meeting was held on February 14, 1979. At this meeting several issues were discussed, including:

- use of the Hidden River as source of drinking water
- determination of velocity of rainfalls in the water quality report
- development of a strategy for Hidden River to protect its' water supply.

In addition, the group reviewed and commented upon the Draft Alternatives Development Task Report.

## TABLE IV-3
## GROUNDWATER TECHNICAL ADVISORY COMMITTEE MEMBERS

| Name | Representing |
|---|---|
| Mr. Mike McCann<br>Geologist | Kentucky Division of Water Quality<br>U.S. 127-South, Century Plaza<br>Frankfort, KY 40601 |
| Dr. William B. White<br>Professor of Geochemistry | College of Earth; Mineral Sciences<br>The Pennsylvania State University<br>210 Materials Research Laboratory<br>University Park, PA 16802 |
| Mr. Thomas Aley<br>Director | Ozark Underground Laboratory<br>Protem, MO 65733 |
| Mr. John Thrailkill | Geology Department<br>University of Kentucky<br>Lexington, KY 40506 |
| Dr. James F. Quinlin | Uplands Research Laboratory<br>Box 8<br>Mammoth Cave, KY 42259 |

# CHAPTER V - LIST OF PREPARERS

## Project Personnel

### U.S. Environmental Protection Agency

| | |
|---|---|
| Robert B. Howard | Chief, EIS Preparation Section |
| Richard D. Green | EIS Project Officer (1977-1979) |
| Ronald J. Mikulak | EIS Project Officer (1979-present) |
| Peter T. McGarry | Chief, North Carolina /Kentucky Facilities Planning Section |
| Daniel C. Lane | 201 Project Engineer |

### Consultants

Gannett Fleming Corddry and Carpenter, Inc.

| | |
|---|---|
| Thomas M. Rachford | Senior Project Manager |
| Richard N. Koch | Project Manager |
| Lynette J. Deuel | Environmental Scientist |
| Jeffrey G. Wendle | Project Engineer |
| Michael S. Moulds | Assistant Project Engineer |

Claude Terry and Associates, Inc.

| | |
|---|---|
| Claude E. Terry | Project Executive |
| Robert J. Hunter | Project Manager |
| James C. Hodges | Environmental Scientist |
| Thomas C. Mather | Environmental Scientist |
| Virginia Hayles | Environmental Scientist |
| Louise B. Franklin | Environmental Planner |

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